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FINAL
REMEDIAL INVESTIGATION AND FEASIBILITY STUDY OF ALTERNATIVES
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

VOLUME I: REMEDIAL INVESTIGATION

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NOTICE

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EXECUTIVE SUMMARY

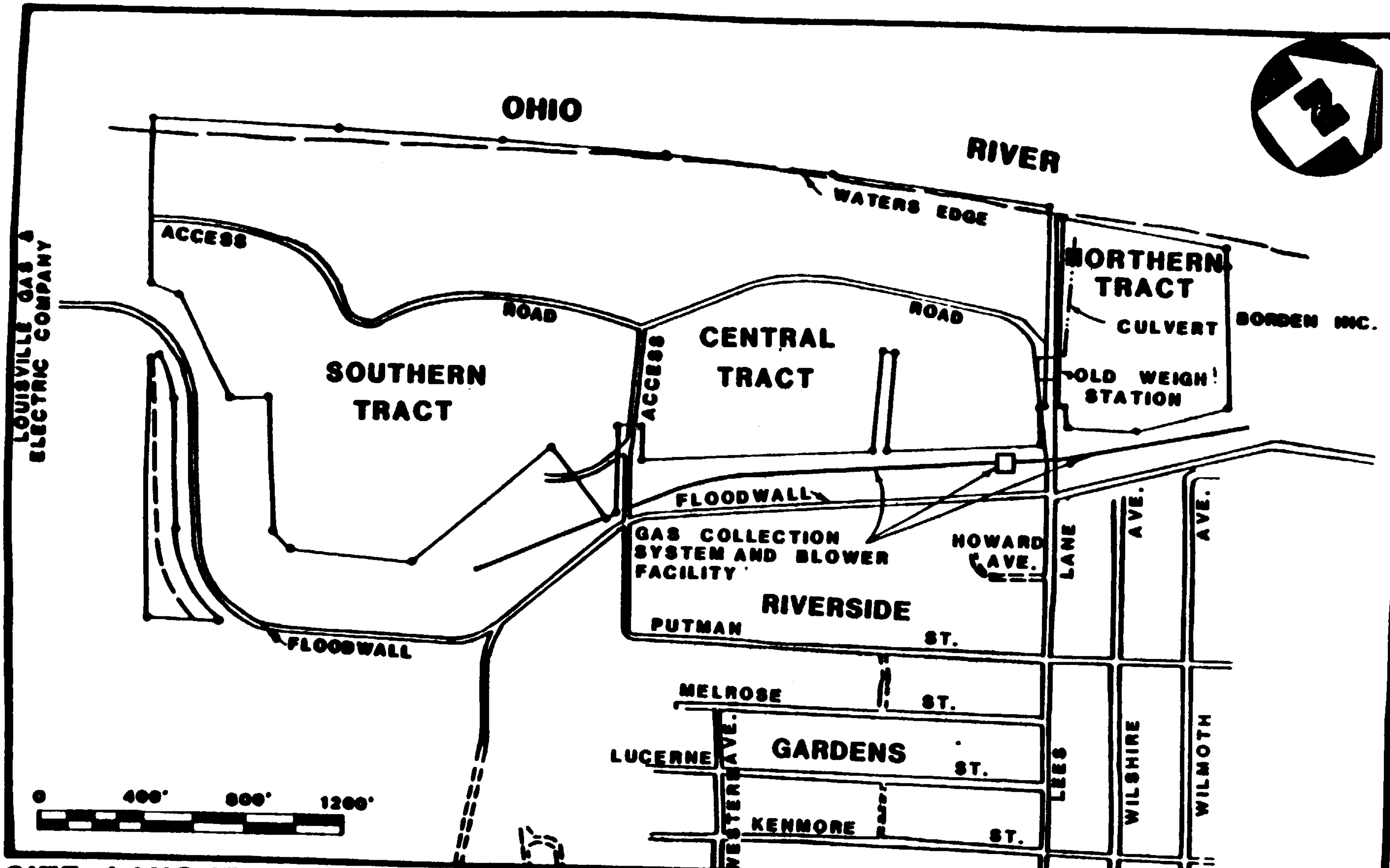
A Remedial Investigation (RI) was performed at the Lees Lane Landfill Site by the NUS Corporation in order to characterize the types and extent of contamination. The purpose of the RI was to compile sufficient data to identify the contaminants of concern, determine potential public health and environmental problems and support the evaluation of technologies and remedial alternatives during the Feasibility Study (FS).

An FS was also performed by the NUS Corporation to assist the EPA in selecting the appropriate remedial action alternative for the Lees Lane Landfill Site. The purpose of the FS was to identify and evaluate remedial alternatives with a range of responses from no-action to offsite disposal and/or treatment. The evaluation of remedial alternatives was based on technological, public health, institutional, environmental and cost factors.

SITE BACKGROUND

The Lees Lane Landfill Site is located adjacent to the Ohio River in Jefferson County, approximately 4.4 miles southwest of Louisville, Kentucky. The site, consisting of approximately 112 acres, is composed of three tracts and measures approximately 5,000 feet in length and 1,500 feet in width (see Figure ES-1). The Northern and Central Tracts of the landfill consist of level to gently sloping land while the Southern Tract contains two depressions with steep slopes. Up to three terraces, each approximately 20 feet wide, form the slope on the river side of the landfill. Much of the landfill surface is covered with well-established vegetation ranging from brush to woodlands. Elevations range from 383 feet above mean sea level (amsl) along the Ohio River to 461 feet amsl along the levee.

The site is bordered on the east and south by a flood protection levee (designed on the 500-year flood). To the northeast is Borden, Incorporated (a chemical manufacturer), to the south is Louisville Gas and Electric, Cane Run Plant (a coal-burning generating station), and to the east is Riverside Gardens (a residential



SITE LAYOUT

LEES LANE LANDFILL SITE

JEFFERSON COUNTY, KENTUCKY

FIGURE ES-1

NUS CORPORATION
A Halliburton Company

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development of about 330 homes and 1,100 people). Beyond these areas the surrounding land use is predominantly woodlands and agricultural land.

Site access is presently unrestricted and the site is occasionally used for recreational purposes such as target practice. Scattered drums and household wastes were observed during the RI suggesting that indiscriminant dumping may still be occurring.

The geology of the site area consists of approximately 110 feet of Ohio River alluvium and glacial outwash underlain by the New Albany shale, reported to be 100 feet thick. The alluvial aquifer is unconfined with the shale forming an aquitard between the alluvial aquifer and the deeper limestone aquifers. The water table is approximately 50 feet below land surface and the saturated thickness of the aquifer is approximately 60 feet. Flow in the aquifer is predominantly toward the Ohio River. Water levels in the aquifer vary with fluctuations of the Ohio River and up to seven feet of variation in water levels were observed during the RI.

Based on a United States Geological Survey boring in the river in 1945, the Ohio River bed is approximately 30 feet above the shale bedrock. The average Ohio River flow at the site is approximately 114,000 cubic feet per second (cfs). Flood conditions occur every 1.2 years and have an average duration of 12 days. Based on the designated 100-year flood level of 447.6 feet amsl, which occurred in 1945, 25 to 50 percent of the landfill would be inundated with water.

Domestic, commerical, and industrial wastes were disposed of in the landfill from the late 1940s to 1975. Prior to and during its use as a landfill, sand and gravel were quarried at the site by the Hofgesang Company. In 1971, the State permitted the Southern Tract of the landfill under its Solid Waste Program. In 1974, the Lees Lane Landfill permit expired and, due to repeated compliance violations, was not renewed.

In March 1975, the Jefferson County Department of Public Health was notified of the presence of methane gas in Riverside Gardens. As a result of explosive levels of methane gas, seven families along Putman Street were evacuated by the Jefferson County Housing Authority. The homes were purchased and the families were relocated at a cost of $150,000. In April 1975, the Kentucky Natural Resources and Environmental Protection Cabinet (NREPC) filed a lawsuit that resulted in landfill closure. All construction requiring excavation was prohibited within 860 feet of the landfill and any construction proposed within 1,500 feet of the landfill required a gas test.

Between 1975 and 1979, 44 gas observation wells were installed in and around the landfill and in Riverside Gardens to monitor the concentration, pressure and lateral extent of methane migration. Samples collected from these wells indicated that the source of the methane and associated toxic gases was the decomposition of landfill wastes. In October 1980, a gas collection system was installed on the site between the fill and Riverside Gardens.

In November 1978, the Surveillance and Analysis Division (SAD) collected samples from residential wells in Riverside Gardens to determine the potential effects of the landfill on groundwater quality. As a result of the study, the SAD reported that there was no indication of the migration of contaminated groundwater from the landfill to the residential wells.

In February 1980, the Kentucky Department of Hazardous Materials and Waste Management (HMWM) discovered approximately 400 drums about 100 feet from the Ohio River bank on a 10-foot vertical rise above the river. In September and October of 1981, the drums were removed by the owners under Court Order. The wastes were removed from the drums and transported to an approved hazardous waste disposal facility. The remaining nonhazardous drummed materials and the empty drums were buried onsite.

In early 1981, the Kentucky NREPC installed eleven shallow groundwater monitor wells at the site; and in April, the SAD collected samples from five of these wells. The SAD reported that many of the sample concentrations were probably elevated due to excessive sediment caused by poor well construction. The report stated that many of the heavy metals and aluminum concentrations should be considered excessive.

In December 1982, EPA evaluated the Lees Lane Landfill Site using the Hazard Ranking System (HRS) as described in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). The overall HRS score was 47.46, which ranked the site in Group 6 on the proposed National Priorities List (NPL). The site received a high ranking due to the distance to the nearest population (300 feet), the floodway location, the identification of landfilled hazardous waste (chromium and vinyl chloride), and the distance to the nearest well (Riverside Gardens).

DESIGN OF THE REMEDIAL INVESTIGATION

Previous studies at the Lees Lane Landfill Site have established two major concerns associated with the site. These two concerns are the result of leachate and gas production by the landfill and are mainly focused on the migration routes of the groundwater and gas contaminants. An additional potential concern is public contact with contaminated surface materials or surface water, sediment and soils on the site since access is not restricted and the site is currently used for recreation.

The levels of contaminants in groundwater and the potential migration routes were investigated through a subsurface boring program, monitor well installation, and groundwater sampling of existing and newly installed wells. Groundwater and Ohio River elevations were also monitored for six months to determine flow pathways.

IT Corporation was tasked by EPA, under a separate contract, to evaluate the condition of the existing gas collection system and to determine the need for upgrading or repair of the system. Samples were collected from the gas extraction wells to determine if the decomposition of the wastes in the landfill was still producing significant levels of methane and associated toxic gases.

An onsite surface sampling program was undertaken to determine the levels of contaminants in surface water, soil and sediments.

MAJOR FINDINGS

The nature and extent of contamination at the Lees Lane Landfill Site was evaluated through a five-step process. First, the contaminants at the site were quantified through a sampling and analysis program. Second, the concentrations of the contaminants thus identified were further evaluated to define the significant contaminants. Third, the distribution of these contaminants was investigated to refine migration pathways and to characterize the site. Fourth, the potential exposure pathways for human and environmental receptors were determined based on site conditions. And finally, the characterization and exposure pathways became the basis for the determination of the public health and environmental concerns.

The onsite migration pathways consist of surface water infiltration to groundwater in the Northern and Central Tracts, with minimum runoff and ponding except during major storms and floods. Surface water infiltration is also expected in the Southern Tract, but runoff to the large pond is a probable pathway due to the steep slopes. The only onsite soil transport likely is by this same route (runoff to the pond) in the Southern Tract.

Onsite surface water contained very low levels of contaminants. Onsite soils and sediments were similar to the offsite background sample collected in Riverside Gardens, suggesting the use of local soils as cover material. In two areas where "hot spot" soil samples were collected, the estimated concentrations of lead and chromium were 2,000 mg/kg (ppm) each. These areas were located along the access road in the Central Tract and are believed to be the result of indiscriminant dumping since the concentrations found were not representative of overall soil concentrations.

The major migration pathway for groundwater is direct discharge to the Ohio River. The groundwater discharge was estimated at 1.69 cubic feet per second (cfs) based on the gradient and hydraulic conductivity measurements made during the RI. This discharge rate results in a groundwater contribution that is 1.5×10^{-3} percent of the total Ohio River flow. If high water conditions on the Ohio River were to exist for a sufficient period of time, groundwater reversal might occur and flow would be toward the Riverside Gardens residential wells. However, there appears to be very little groundwater migration resulting from the operation of the pumping center to the northeast of the site. Insufficient data are available to eliminate the potential for the transport of contaminants under the Ohio River. However, based on the potential dilution by the Ohio River, the low groundwater gradient at the site (maximum observed at 0.007), and the essentially flat bedrock (dipping at 8.3 feet per mile) beneath the site, the effects of contaminant migration under the Ohio River are expected to be inconsequential.

Onsite groundwater contained low levels of organic compounds and some inorganic contaminants. The major inorganic contaminants included arsenic (87 ug/l), barium (1,100 ug/l), cadmium (22 ug/l), chromium (640 ug/l), lead (150 ug/l), manganese (44,000 ug/l) and iron (190,000 ug/l). The offsite concentrations of these contaminants were all below the maximum contaminant levels (MCL) set in the Interim Primary Drinking Water Regulations. Manganese was detected at 610 ug/l in the Louisville Gas and Electric well and at 370 ug/l in an Indiana public water supply (PWS) well. Iron was detected at 8,900 ug/l in an Indiana PWS well, but was below background in both industrial wells. Neither manganese or iron are considered to have significant health effects.

The IT Corporation (IT) evaluation of the existing gas collection system concluded that the system was operating at less than 50% efficiency. Monitoring has been conducted by Jefferson County since 1980 and the only time methane has been detected in the gas observation wells in Riverside Gardens was in April and May of 1984 when the blower system was not operating properly. This suggests that although the system requires repair or replacement, it is currently mitigating gas migration at the site. Samples collected by IT from the gas extraction wells contained both methane and toxic gases, demonstrating that the decomposition of landfill wastes is still producing gases with the potential to migrate to Riverside Gardens. In November 1985, the Jefferson County Department of Public Works contracted SCS Engineers to inspect the gas collection system. Repairs of problem areas noted during the inspection were begun in December 1985 by Jefferson County under the supervision of SCS Engineers.

The public health assessment concluded that the primary public health concern at the site was the elevated chromium levels found in onsite groundwater. It is also concluded that there was no evidence of an offsite public health or environmental problem related to the site at this time. Remediation of groundwater was not indicated by the public health assessment, but the need for long-term monitoring of groundwater and ambient air was identified to establish baseline conditions and to serve as an early detection system should site conditions change. The public health assessment recognized that the existing gas collection system is mitigating gas migration, but the system may need to be repaired or replaced. A routine subsurface gas monitoring program also needs to be implemented outside the collection system and in Riverside Gardens. The public health assessment also noted that, in the absence of controlled access to the site, the surface wastes should be removed and the soils containing elevated levels of chromium and lead should be covered.

ADDITIONAL DATA NEEDS

The groundwater monitoring program conducted during the RI consisted of two periods of sample collection, one month apart. The only previous onsite groundwater samples were collected in 1981. Baseline groundwater quality conditions should be established for the site so that a more accurate evaluation of groundwater degradation or improvement over time can be made. Considering the groundwater flow conditions at the site and the potential effects of flood stages in the Ohio River, the definition of baseline groundwater quality conditions is expected to require approximately two years of quarterly data collection. In addition, ambient air sampling in Riverside Gardens and on the landfill is being conducted as a separate study by the EPA. The results of this study will be issued as an addendum to the RI/FS Report.

REMEDIAL ACTION ALTERNATIVES

A two-phased process was used to determine the appropriate remedial response at the Lees Lane Landfill Site. First, an initial screening of technologies was performed to eliminate the infeasible, inappropriate, or environmentally unacceptable technologies. The second phase involved a detailed analysis of a limited number of remedial alternatives formed from the technologies that passed the initial screening stage.

The remedial alternatives were developed using best engineering judgement to select a technology or group of technologies that best addressed the problems existing at the site. The alternatives were developed to offer the EPA, as the remedial action selection agency, a range of responses for site remediation while still addressing the public health concerns identified at the site. An alternate water supply for ten homes in Riverside Gardens is included in alternatives two, three, and four, on a discretionary basis. The EPA will decide on the applicability of including this technology at a later time. The alternatives so identified are presented in Table ES-1.

These alternatives are all considered to be source control remedial actions. This type of remedial action is defined as that applicable where the hazardous substances remain at or near the areas where they were originally located and are not adequately contained to prevent migration to the environment. The alternatives consist of combinations of the following operable units:

- Monitoring of Air, Gas and Groundwater
- Inspection and Repair of the Gas Collection System (Potential installation of a gas burner)
- Cleanup of Surface Waste Areas
- Installation of a Cap (Requiring removal of surface waste materials and grading and vegetation)
- Installation of Bank Protection Controls
- Excavation of Landfill Materials and Onsite Incineration (Requiring offsite disposal and backfilling, grading, and vegetation)
- Excavation of Landfill Materials and Offsite Disposal (Requiring backfilling, grading and vegetation)

The no action alternative, which consists of groundwater, air and gas monitoring only, may not be effective in mitigating public health concerns caused by the ultimate failure of the gas collection system or potential public contact with contaminated materials on the landfill surface.

TABLE ES-1
SUMMARY OF REMEDIAL ACTION ALTERNATIVES
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Alternative	Cost ($) 1,000 Actual	Cost ($) 1,000 Present Worth	Public Health Concern	Environmental Concern	Technical Concern	Other Concerns
1. No Action - Monitoring	391	341	Gas migration and direct contact with surface wastes	Leachate and waste release to Ohio River	-	Community disapproval
2. Gas Collection and Venting System, and Monitoring	647	439	Direct contact with surface wastes	Leachate and waste release to Ohio River	-	-
3. Surface Waste Area Cleanup, Bank Protection Controls, Gas Collection and Venting System, and Monitoring	2,909	2,682	Minimal	Leachate release to Ohio River	-	-
4. Capping, Regrading and Revegetation, Surface Waste Area Cleanup, Bank Protection Controls, Gas Collection and Venting System, and Monitoring	42,683	15,946	Minimal	Leachate release to Ohio River	Time for implementation Cap damage from Ohio River runon during flooding	Transportation of capping material through Riverside Gardens
5. Excavation and Backfilling, Regrading and Revegetation, Onsite Incineration, Offsite Fly Ash Disposal, and Monitoring	418,112	165,766	Gas and particulate migration during excavation	Migration of wastes from flooding during excavation	Coordination of excavation and incineration. Time for implementation	Transportation of wastes through Riverside Gardens
6. Excavation and Backfilling, Regrading and Revegetation, Offsite Disposal, and Monitoring	649,279	261,538	Gas and particulate migration during excavation	Migration of wastes from flooding during excavation	Coordination of excavation and transportation of wastes. Time for implementation	Transportation of wastes through Riverside Gardens

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The second and third alternatives both include groundwater, air and gas monitoring, a potential future alternate water supply, and inspection and repair of the gas collection system. The third alternative adds cleanup of surface waste areas and installation of bank protection controls. These alternatives have been defined as those which do not attain applicable or relevant public health or environmental requirements but will reduce the likelihood of present or future threat from the hazardous substances and which provide significant protection to public health, welfare, and the environment.

The fourth alternative is expected to satisfy all applicable and relevant Federal public health or environmental requirements. This alternative includes groundwater, air and gas monitoring, inspection and repair of the gas collection system, a potential future alternate water supply, cleanup of surface waste areas, installation of a clay cap including regrading and revegetation, and installation of bank protection controls.

The alternative which exceeds all applicable or relevent public health or environmental requirements includes excavation and onsite incineration. The excavation of the 2,400,000 cubic yards of waste estimated to be at the landfill would be incinerated onsite to reduce the volume and toxicity. The fly ash and materials not suitable for incineration would be transported to an offsite facility. The site would be backfilled, regraded and revegetated. A groundwater, air, and gas monitoring program would also be conducted.

The final alternative was developed to address treatment or disposal at an off-site facility. This alternative includes excavation of the same materials described under alternative five, but the waste would be disposed of in a secure offsite EPA-approved RCRA landfill. The excavation, backfilling, and monitoring would also be performed in a manner similar to that described in the fifth alternative.

1.0 INTRODUCTION

A Remedial Investigation (RI) and Feasibility Study (FS) was performed at the Lees Lane Landfill Site by the NUS Corporation, Region IV Field Investigation Team. The work was assigned by the EPA Region IV under Contract Number 68-01-6699. The Comprehensive Environmental Response Compensation and Liability Act of 1980 (CERCLA) authorizes the EPA to develop a remediation plan for those sites which are a potential threat to the public health, welfare and the environment. The Lees Lane Landfill Site was recognized as a potential problem to the public in 1975 as a result of gas migration studies at the site and was placed on the National Priorities List in 1982 (Federal Register, 9-8-83). Within the remedial planning program, the RI and the FS at the Lees Lane Landfill Site are EPA-led studies in support of federal enforcement action.

The purpose of the RI is to compile sufficient data to characterize the site, to identify contaminants of concern, to determine public health and environmental concerns, and to support the screening of technologies and remedial alternatives. An evaluation of the remedial alternatives is based on technological, public health, institutional, costs, and environmental factors. The purpose of the FS is to identify and evaluate remedial alternatives with a range of responses from no-action to offsite disposal and/or treatment. The selection of an appropriate alternative is made by the EPA.

1.1 Site Background

The Lees Lane Landfill Site, a tract of land of approximately 112 acres, is located along the Ohio River in Jefferson County, Kentucky. The landfill is approximately 4.4 miles southwest of Louisville, Kentucky (Figure 1-1). A location reference point for the landfill is the intersection of Lees Lane and the flood protection levee. This point is located at 38°11'44" N latitude and 85°52'17" W longitude. The site is approximately 5,000 feet in length, averages approximately 1,500 feet in width and consists of three tracts of land designated as the Northern, Central, and Southern Tracts (NUS, 1983a).

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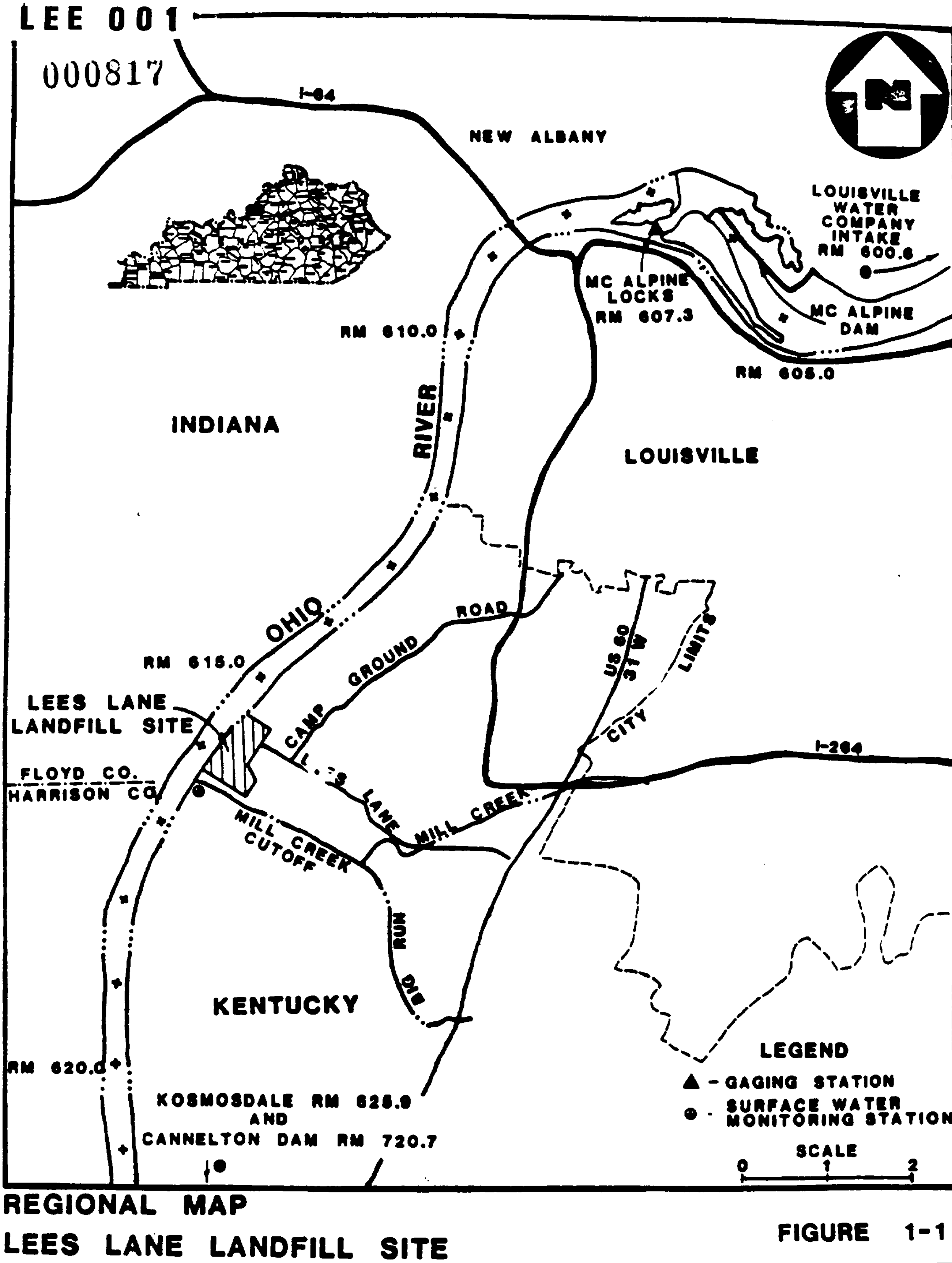

REGIONAL MAP
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

FIGURE 1-1

NUS CORPORATION
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The site is bordered on the east and south by the Army Corps of Engineers flood protection levee. To the northeast is Borden, Inc. (a chemical manufacturer), to the south is Louisville Gas and Electric Cane Run Plant (a coal burning generating station), and to the east is Riverside Gardens (a residential development of about 330 homes and 1100 people). The west side of the site has a narrow, terraced area which serves as a buffer zone between the landfill and the Ohio River. A gas collection system has been installed along the property boundary to the southwest of the site between the landfill and Riverside Gardens (see Figure 1-2).

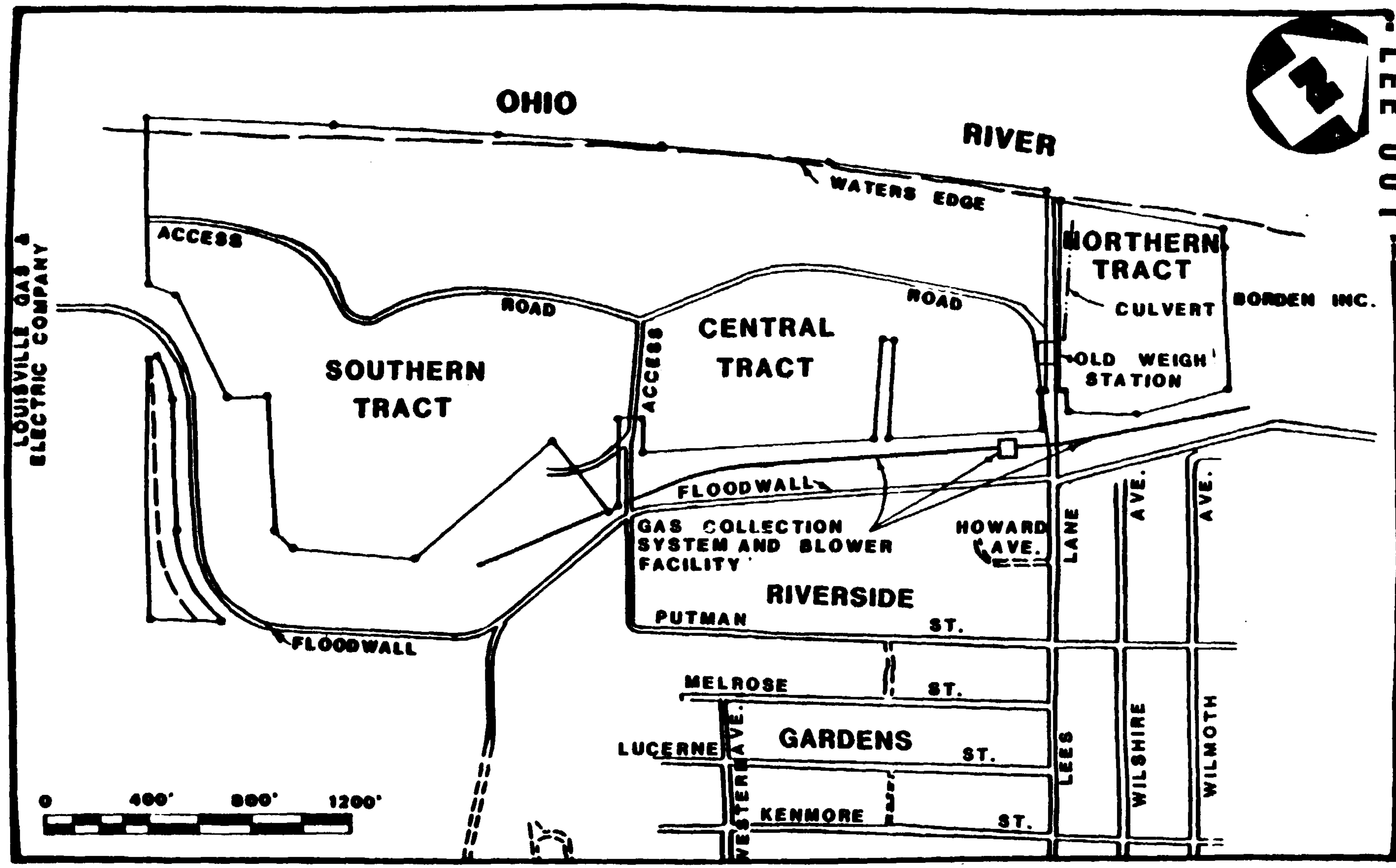
1.1.1 Environmental Setting

The topography of Lees Lane Landfill has been determined mainly by the extensive man-made excavation and fill operations at the site. A secondary, but major influence of the topography has been the erosional and depositional processes of the Ohio River. The landfill is located in the Ohio River Terraces physiographic province.

The Northern and Central Tracts of the landfill consist of level to gently sloping land. The Southern Tract contains two steep-sided excavations. Up to three terraces, each approximately 20 feet wide, comprise portions of the slope on the river side of the landfill. Elevations range from 383 to 410 feet above mean sea level (amsl) along the Ohio River to 461 feet amsl along the levee.

The geology of the site consists of unconsolidated alluvial and glacial deposits. The deposits consist of clay, silt, sand and gravel in a downward coarsening sequence. The thickness of the unconsolidated material ranges up to 110 feet. Below the alluvial and glacial deposits is a shale bedrock reported to be 100 feet thick and beneath the shale is a series of limestones.

The hydrogeology at the site consists of an alluvial aquifer that occurs approximately 50 feet below land surface and is approximately 60 feet thick. The alluvial aquifer is the principal, local water-bearing formation in the area and is capable of yielding large quantities of water. The wells encountered in the area were all screened in the alluvial aquifer.



SITE LAYOUT
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

FIGURE 1-2

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1.1.2 Site History

Land use at the Lees Lane Landfill Site has included a sand and gravel quarry, a junkyard and a landfill. The period of sand and gravel operations at the site is not known but quarrying began at least as early as the 1940s. The landfilling operations at the site were reported to have begun in the late 1940s. Based on available historical photographs, refuse and old automobiles were observed in the Central Tract in 1955; active refuse disposal was observed in the Central Tract in 1959; and fill and active refuse disposal were observed in the Southern Tract in 1971.

From the aerial photographs fill operations appear to have been initiated as open dumping along the southern and central tracts of the property. Dumping, in all likelihood, also occurred in the open sand and gravel pits during this same time period. Open dumping at the front of the property stopped sometime during the 1960s and all dumping was then limited to the sand and gravel pits.

Aerial photographs taken on March 30, 1971 show that extensive excavation and fill operations were being conducted. Fill areas are located in the Central and Southern Tracts and excavation areas in the Northern and Southern Tracts. Background information for the site indicates that the Northern Tract excavation area was eventually filled with wastes but that the site was closed before the excavation area in the Southern Tract was completely filled. A large depression with ponded water now exists where remaining landfill capacity existed at the time of closure.

The site operated for a time under a permit for the Southern Tract issued in 1971 by Kentucky under its Solid Waste Program. The permit expired in November 1974 and was not renewed by the State. In March 1975, home owners in Riverside Gardens, a community adjacent to the site, reported flash fires around their water heaters. A subsequent investigation detected explosive levels of methane gas and seven families were evacuated from homes near the site. These homes were ultimately purchased by the Jefferson County Housing Authority. In April, 1975 the landfill was closed.

1.1.3 Previous Investigations

A number of studies have been conducted at the site starting in 1975. These studies have included a series of investigations to evaluate the methane gas problems and a series of investigations to evaluate groundwater contamination.

During 1975, studies were performed by the Jefferson County Department of Health and the Surveillance and Analysis Division (SAD) of EPA, Region IV, on the methane gas problems at the site. These studies concluded that a methane and toxic gas problem existed at the site and in Riverside Gardens and recommended that a gas venting system be installed. A subsequent study was done by SCS Engineers in 1978 and a report was issued by the EPA National Enforcement Investigations Center (NEIC), Denver in late 1978. These studies confirmed the methane gas problem onsite but did not find a problem in the Riverside Gardens homes. A gas collection/venting system was designed and installed on the site by SCS Engineers in October 1980.

In February 1980, the Kentucky Department of Hazardous Materials and Waste Management (HMWM) found approximately 400 drums on the site. Court actions were taken against the site owners and the drums were emptied of liquid wastes for proper disposal and the drums and solid wastes were buried onsite.

A number of groundwater studies have been conducted on the site and in Riverside Gardens. In November 1978, SAD EPA Region IV, collected groundwater samples from eleven private wells in Riverside Gardens. In December 1978, SAD resampled five of the eleven wells sampled in November. The results of this study stated that there was "no indication that the aquifer immediately underlying the Lees Lane Landfill is contaminated with either metals or organic compounds from leachate intrusion." In early 1981, Kentucky installed eleven groundwater monitor wells at the site. Five of these wells were subsequently sampled by the EPA (SAD). Analytical results showed elevated levels of inorganic compounds. However, it was believed that the results were affected by the presence of excessive sediment in the samples caused by improper well construction. In November 1982, the Region IV FIT (Ecology and Environment, Inc.) inspected the site and found a leachate outbreak on the southern end of the landfill adjacent to the Ohio River. A water sample and sediment sample were taken from the leachate seep. Ecology and Environment also conducted a resistivity and magnetometer survey of the site.

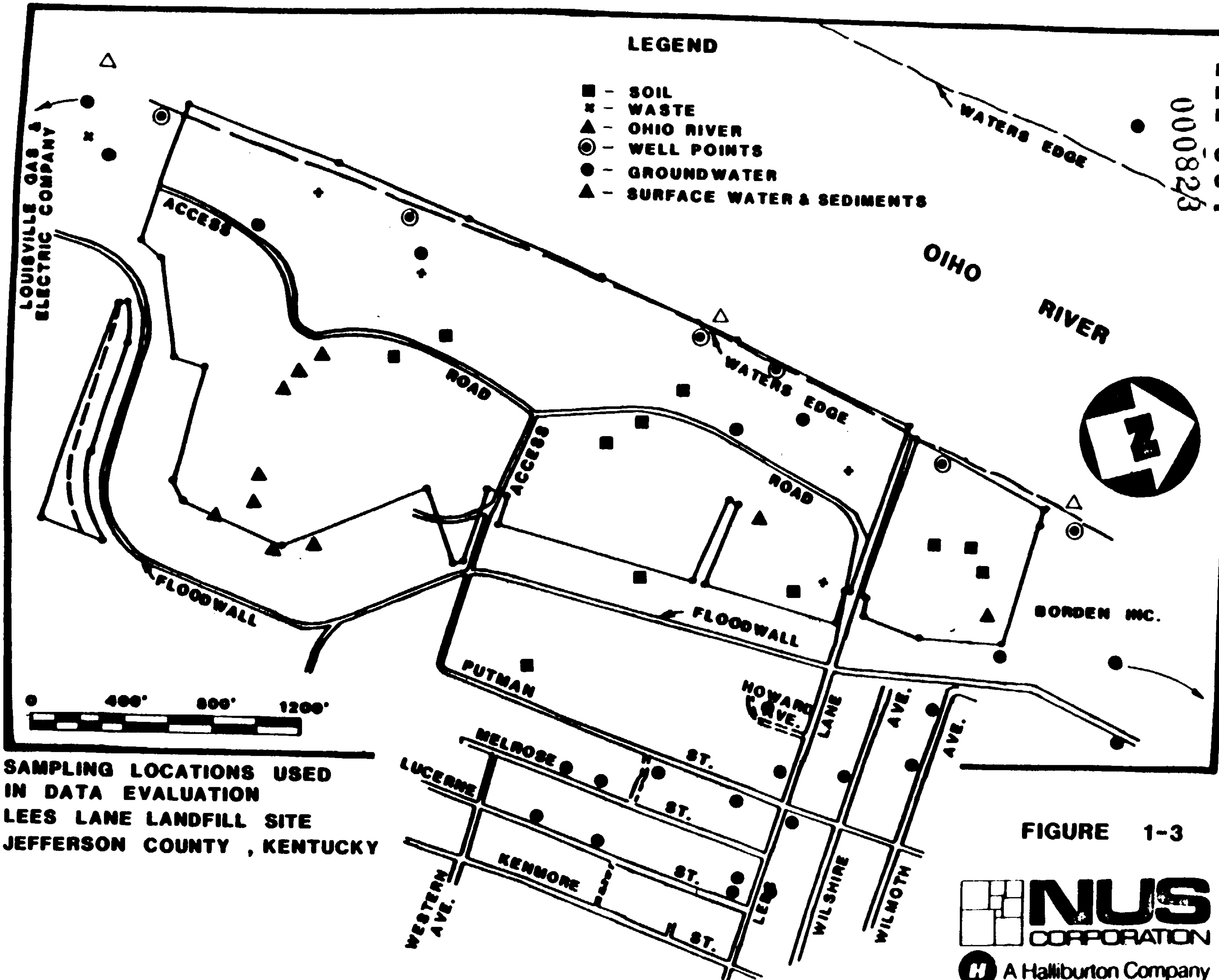
During a site visit conducted by FIT (NUS Corporation) in January 1983, approximately 25 drums were discovered in heavy underbrush near the river on the Southern Tract. The EPA Emergency Response Unit inspected these drums and concluded that they did not pose an immediate threat to the public; and therefore, did not require an emergency removal. The EPA determination at the time was that these drums should be addressed during remedial action at the site. In July 1983, Region IV FIT (NUS Corporation) conducted a subsurface investigation and collected two groundwater samples and one soil sample.

The current Remedial Investigation has included an evaluation of the previously collected data and the installation and sampling of five new monitor wells and the sampling of existing onsite monitor wells, residential, industrial and public supply wells, surface soil, sediment and water, and the Ohio River. Figure 1-3 shows all of the sample locations for data used during the Remedial Investigation.

1.1.4 Site Use and Ownership

The Northern and Central Tracts were owned by Jos. C. Hofgesang until his death on March 10, 1972. Following his death, ownership went to the current owner, the Hofgesang Foundation, Inc., which is a private foundation set up in perpetuity. The Southern Tract was owned up to the mid 1960's by Gernert Court, Inc. During the mid 1960s, the company's name was changed to the Jos. C. Hofgesang Sand Co., Inc. This company owned the site until the Kentucky solid waste permit expired in November 1974, at which time J. H. Realty, Inc. acquired it. J. H. Realty, Inc. is the current owner of the Southern Tract.

A property survey of the site was conducted by AmTech Engineering, Inc. of Indianapolis, Indiana. The plat of survey was completed on November 1, 1984 and signed by Kentucky Registered Land Surveyor #203, R.R. Waddle and by Kentucky Registered Land Surveyor #2207, Leslie M. Haney. A detailed presentation of the property boundary is included in Appendix A.



SAMPLING LOCATIONS USED IN DATA EVALUATION
LEES LANE LANDFILL SITE
JEFFERSON COUNTY , KENTUCKY

FIGURE 1-3

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The site is currently used for recreational purposes mainly by local residents from Riverside Gardens. Recreational use includes: hunting, target practice, dog walking and hunting, dog training, and as an access to the Ohio River for fishing. Illegal dumping of construction debris, tires, and household refuse also occurs at the site.

1.1.5 Planned Use of Site

The Louisville-Jefferson County Planning Commission Comprehensive Plan of 1979 proposed that the land area occupied by the Lees Lane Landfill be designated for industrial use. According to the Planning Commission the use of such land for industrial siting is predicated on the landfill material being treated and/or disposed of to alleviate all hazards, and to ensure that the land area is not in violation of applicable state and Federal rules and regulations.

1.1.6 Community Awareness

Community awareness at the Lees Lane Landfill site has been centered primarily on the Riverside Gardens housing development. Riverside Gardens has an active citizens organization, Riverside Gardens Community Council, organized in 1969. This group is headed by Mrs. Pat Moran and has spearheaded community development efforts for the neighborhood (NUS, 1983b).

The residents of Riverside Gardens were aware of the dumping taking place in the landfill and filed an official complaint with the county in 1964. Problems continued at the landfill through the late 1960s and early 1970s with serious concern about reported "midnight dumping".

The Lees Lane Landfill Advisory Committee, comprised of state and county officials, was organized in 1975 to investigate a methane gas problem reported in the neighborhood. The committee ultimately determined that the methane problem was being caused by the landfill.

In 1978, the Lees Lane Landfill Methane Gas Task Force was formed and headed by Mr. Ed Robinson of the Jefferson County Department of Public Works. The work of this task force ultimately resulted in the installation of a gas venting system in 1980 (NUS, 1983b).

The Jefferson County Health Department has conducted monthly monitoring of emissions from monitoring wells and the County Department of Public Works was charged with the maintenance of the gas venting system.

1.2 Investigation Summary

The available site information was compiled and evaluated to determine the potential site problems for use in the study design. The Remedial Investigation was designed to determine the level of contaminants, the migration pathways and the potential public health and environmental concerns.

1.2.1 Problem Identification

Existing site information has been compiled and presented in two major documents: the Remedial Action Plan (RAP) prepared by Ecology and Environment in December 1981 and the Lees Lane Landfill Remedial Action Master Plan (RAMP) prepared by NUS Corporation in May 1983. The information contained in these two plans and existing EPA and state files combined with a site visit in September 1984 were used to assess the problems existing at the site and to determine preliminary remedial technologies applicable to the control of the potential problems identified.

Three major categories of potential site problems were identified. These problems include gas production and migration, leachate production and migration to groundwater and contamination of surface water, soil or sediment. Gas migration problems were identified at the site in 1975 and a gas collection system was installed in 1980. Based on monitoring by the County, it appeared that the existing system was controlling the migration of toxic and explosive organic compounds to Riverside Gardens. Leachate migration to groundwater was expected based on site conditions and was confirmed by past sample collection efforts. Contamination of surface water and sediments and/or soils through drum staging, spillage and/or leakage and leachate seepage are potential site problems based on previous studies and the identification of existing onsite drums.

The following general response actions were identified as applicable to the control of potential site problems.

- Provision of an alternate water supply to residents of Riverside Gardens
- Containment of contaminated groundwater through the use of groundwater barriers and capping of the landfill
- Collection of leachate and/or gas combined with venting and/or treatment
- Pumping of contaminated groundwater through the use of extraction wells
- Removal of contaminated soils and/or sediments and surface water
- Treatment of removed materials (groundwater, soils, sediments or surface water) either onsite or offsite
- Removal of surface wastes and proper disposal
- Excavation of waste materials
- Treatment and disposal of waste materials either onsite or offsite

In October 1984 EPA approved the work plan prepared by NUS Corporation for the performance of the Remedial Investigation at the Lees Lane Landfill Site.

1.2.2 Study Design

The Remedial Investigation was designed to determine the levels of contaminants at the site and to define the potential migration pathways away from the site. Based on the large number of previous studies conducted at the site, much of the data needed for the evaluation of site conditions was already available and the field data collection activities were limited to supplementing the existing data base through the following activities:

- Location of the approximate fill boundaries (see Section 3.2.2.1)
- Evaluation of erosion of the Ohio River bank adjacent to the site and need for bank protection controls (see Section 3.2.2.2.)
- Description of the hydrogeology beneath the site (see Section 4.3)
- Determination of the presence or absence of contamination in the alluvial aquifer in and around the site (see Section 4.5)
- Investigation of potential groundwater pathways (see Section 4.3.4)
- Determination of the presence or absence of contaminants in onsite surface water, sediments and soils (see Section 5.4)
- Evaluation of the effectiveness of the existing gas collection system (see Section 6.4.2)

A major concern of the site was the potential migration of contaminated groundwater. Three pathways were identified during the problem assessment phase and the RI was designed to provide the information necessary to assess each pathway. Groundwater discharge to the Ohio River was investigated through the collection of shallow groundwater samples at the Ohio River bank, onsite and upgradient of the fill. A shallow upgradient monitor well was installed in Riverside Gardens and six temporary well points were set in the Ohio River bank. The shallow groundwater monitoring network consisted of one upgradient, three onsite, and six downgradient groundwater sampling points. Nearshore samples of the Ohio River were also collected adjacent to three of the temporary well points. The analyses of these samples were used to evaluate the changes in groundwater quality as it passed through the landfill.

Based on the site geology, there is a potential for the migration of contaminated groundwater under the Ohio River. This pathway was investigated through the collection of groundwater samples from the base of the aquifer upgradient of the site, onsite and on the Indiana side of the Ohio River. A deeper upgradient monitor well was installed in Riverside Gardens and below the fill in the Central Tract opposite the public water supply wells in Indiana. The monitoring network at the base of the aquifer consisted of one upgradient, two onsite and two downgradient (in Indiana) groundwater sampling points. The analyses of these samples were used to determine the potential for migration of contaminated groundwater under the Ohio River.

The third potential groundwater migration pathway was toward Riverside Gardens or the pumping center located to the northeast of the site. Migration to Riverside Gardens was investigated through the installation of a continuous water level recorder on the monitor well installed in the fill in the Central Tract. The changes in water level indicated by the recorder were used to evaluate the effect of Ohio River water levels on groundwater water levels at the site. Groundwater samples were also collected from the five wells in use in residential Riverside Gardens. Migration as a result of the pumping center was investigated through the installation of a monitor well with a 35-foot screen between the site and the pumping center. This well was also sampled and equipped with a continuous recorder.

The RI groundwater monitoring network was designed to use as many existing wells as possible to conserve time and money as well as to avoid potential health and safety problems arising from drilling through the fill materials. The new wells that were installed as part of the RI were located outside the fill boundaries, whenever possible, due to the production of methane and other toxic gases within the landfill. The groundwater monitoring network for the RI consisted of the following:

- Two upgradient monitor wells, one shallow and one at the base of the aquifer
- Five upgradient shallow residential wells in Riverside Gardens
- Three shallow onsite monitor wells
- Three downgradient monitor wells at the base of the aquifer

- Two offsite deep industrial wells located to the northeast and southwest of the site

- Six downgradient shallow temporary well points on the Ohio River bank.

A second concern at the site was the migration of combustible and toxic landfill gases to Riverside Gardens. Numerous studies of this problem had been conducted from 1975 to 1980 before the gas collection system was installed and little additional data was needed. The major concern was the condition of the existing system since very little maintenance had been performed. EPA tasked IT Corporation, under a separate contract, to conduct an evaluation of the gas collection system and to determine the need for upgrading or modification.

Surface contamination problems at the site were expected to be minimal since the site was closed and covered; however, site access is not restricted and public contact with contaminated surface media is possible. Surface soil samples were limited to potential "hot spots" based on visual observations. Surface water and sediment samples were collected from a pond in the large depression in the Southern Tract and a marsh area near the pond. Two areas of standing water in the Northern and Central Tracts were also sampled. The analyses from the soil and sediment samples were used to evaluate onsite soil transport and the nature of the cover materials. The analyses from the surface water samples were compared to groundwater to determine if groundwater discharge was occurring.

1.3 Nature and Extent of Problem

The discussion of the nature and extent of the problem at the Lees Lane Landfill Site has focused on the waste materials present at the site and the potential for the release of contaminants the effects of the migration of these contaminants, and the public health and environmental concerns associated with the contaminants and their concentrations observed at the site.

1.3.1 Nature of Waste Materials

The Lees Lane Landfill Site was used for the disposal of domestic, commercial, and industrial wastes from the late 1940s to 1975. No records are available as to the type or quantity of waste disposal at the site; but a Congressional Inventory conducted in 1979 suggests that at least 212,000 tons of diversified chemical wastes were disposed of by four companies between 1948 and 1974. The majority of the wastes at the site are believed to have been placed in the areas excavated during the quarrying of sand and gravel at the site. Based on standard landfilling practices at the time, it is reasonable to assume that the wastes were comingled within the disposal areas.

The volume of fill at the site has been estimated based on the interpretations of historic aerial photographics provided by the Environmental Photographic Interpretation Center (EPIC), current site topography, and the results of magnetometer surveys. The estimated volume of 2.4×10^6 cubic yards is considered useful only for FS purposes and may not represent the actual volume of materials disposed of at the site.

The site is currently covered with what appears to be locally-derived soils of varying thickness throughout the site. The current site topography is relatively flat with two depressions located in the Southern Tract where remaining capacity existed at the time of closure in 1975. The lack of standing water throughout the site suggests that the cover material is permeable. The site also exhibits well-established vegetation ranging from grasses and shrubs to woodlands. The combination of permeable soil cover materials and widespread vegetation suggests that most rainfall infiltrates the landfill surface rather than leaving the site as runoff to the Ohio River. Site runon and runoff are inhibited by the flood protection levee to the east and south and the topography to the north of the site.

Infiltrating rainfall can be expected to contribute to leachate production within the waste materials but during normal stages of the Ohio River, the groundwater beneath the landfill is not expected to intersect most areas of waste disposal. There are no known liners or leachate collection systems at the site; and the leachate produced by the decomposition of the wastes will be released and is likely to migrate to groundwater or emerge as leachate seeps along the Ohio River bank.

In addition to the production of leachate, the decomposition of the waste materials produces gases consisting predominantly of methane and carbon dioxide. Depending on the waste materials present, other toxic gases have been produced by the landfill in the past. The permeable cover material can be expected to allow the release of these gases to the atmosphere where they are diluted by ambient air. Prior to the installation of a gas collection system in 1980, methane had migrated in the subsurface soils to Riverside Gardens.

1.3.2 Migration Routes and Receptors

Contaminants at the site can be released to the environment through the migration of leachate to groundwater, transport of soils and surface water through runoff, and through the migration of gases to the atmosphere.

The predominant groundwater migration route identified as a result of the Remedial Investigation was discharge of shallow groundwater to the Ohio River. Conservative calculations of the potential groundwater flow to the Ohio River is 1.69 cubic feet per second (cfs). The average flow of the Ohio River at Louisville is 114,000 cfs, suggesting that the groundwater contribution is 1.5×10^{-3} percent of the total flow in the Ohio River.

The bedrock beneath the site dips approximately 8.3 feet per mile toward the Ohio River and the maximum groundwater gradient observed during the RI was 0.007. There are 30 feet of sediments beneath the Ohio River bed and above the underlying shale bedrock and the transport of groundwater contaminants beneath the Ohio River is possible.

Transport of contaminants in shallow groundwater away from the Ohio River and toward Riverside Gardens is also possible. On at least two occasions during the conduct of the RI, groundwater elevations in a well located 800 feet from the Ohio River were higher than the groundwater elevations observed in a well located 250 feet from the River. Considering that the Ohio River flood levels were approximately 10 feet lower this year than the designated Ohio River flood stage (less than 418 feet and 428 feet amsl, respectively), transport of groundwater contaminants away from the Ohio River can not be discounted.

A continuous water level recorder was placed on a monitor well to the east of the site to determine the potential for groundwater diversion as a result of the pumping center located to the northeast of the landfill. Evaluation of the results suggests that the variations in the groundwater levels in this well are related to the Ohio River water levels rather than to pumping.

The surface water and surface soil migration routes at the site appear to be inconsequential. As noted earlier, most rainfall appears to infiltrate the cover material rather than migrating through overland flow. Topographic features at the site are expected to limit both runon and runoff of rainfall except to the Ohio River where dilution and sediment transport are expected to mitigate any affects. Some onsite erosion and sediment transport is expected in the Southern Tract where steeper slopes will facilitate surface water runoff. The eroded materials or surface runoff will be collected in the pond in the large depression in this area. The materials thus collected are expected to be released offsite only through the occurrence of the designated 50-year flood (or greater) when this area would be susceptible to transport by flood waters.

Gas produced by the landfill will migrate radially from the site including vertically through the cover material and laterally through the subsurface materials. Once the gases leave the landfill where the cover materials are relatively permeable, the upper 10 to 12 feet of natural soils in Riverside Gardens are expected to restrict the release of these gases since these soils are relatively impermeable. The gases can be expected to migrate laterally until more permeable surface soils are encountered or until excavation of these materials for man-made structures provides a vertical pathway. Studies conducted from 1975 to 1979 identified that methane had migrated as far as 900 feet from the landfill boundary. In 1980, a gas collection system was installed between the landfill and Riverside Gardens and it appears to have mitigated the migration of gases toward the residential area.

The main receptors for contaminant releases from the site are the residents of Riverside Gardens (approximately 1,100 people). Industries are located to the northeast and southwest of the landfill (Borden, Inc. and Louisville Gas and Electric, Cane Run Plant, respectively) along the Ohio River. A residential area of approximately 50 homes is located across the Ohio River in Indiana as is the Edwardsville Water Company public water supply well field. The closest known downstream public water supply intake on the Ohio River is West Point, Kentucky (14 miles downstream). The Louisville public water supply has been extended into Riverside Gardens and there are known to be only eight families currently using private drinking water supply wells in the neighborhood. Access to the landfill proper is currently uncontrolled and recreational use is evident.

1.3.3 Potential Public Health and Environmental Concerns

The contaminants identified through sampling and analysis at the Lees Lane Landfill Site have been evaluated in a systematic manner designed to identify any potential public health or environmental concerns associated with the site. The evaluation included both historical data as well as that data collected during the Remedial Investigation in an effort to define both the current concerns as well as the potential for future problems.

Since the groundwater media contained the greatest distribution of contaminants, the range of concentration of each constituent found in the samples collected during the RI was assembled and tabulated. These concentrations were then compared to available standards, advisories, and guidance to identify elevated levels of any constituents. Those constituents, thus identified, were further evaluated to determine if the distribution of the constituent suggested that the concentrations could be related to site contaminants. The resulting constituents were considered contaminants of interest. The distribution of these contaminants of interest was then used to describe the observed migration pathways and the potential exposure pathways for each environmental media.

A second, independent evaluation was performed on the tabulated ranges in concentration for each constituent. This evaluation considered the significant public health effects and toxicological potential based on the distribution of the concentrations of the constituents present. The constituents, so identified, were considered to be the contaminants of concern. The potential public health and environmental concerns were then defined for each contaminant. Since groundwater contamination problems had been identified in the past, the detailed description of the public health and environmental concerns was directed toward groundwater; however, each media was described in sufficient detail to evaluate the potential public health and environmental concerns.

The independent nature of these two evaluations can be best illustrated by the inclusion of benzene as a contaminant of concern even though it was eliminated as a contaminant of interest based on its distribution. The contaminants of interest identified for the Lees Lane Landfill Site include arsenic, barium, chromium, lead, manganese, and iron. The corresponding contaminants of concern are benzene, chromium, lead, and arsenic.

The reliability of the data collected during the RI was also evaluated as to whether it was representative and characteristic for each media. Characteristic data was defined as that data collected over a sufficiently long period of time to establish baseline conditions for that media. For instance, concentrations of constituents in soil are not expected to vary significantly over time but the same is not to be expected in groundwater. Representative data was defined as that data collected over a sufficiently large area to reflect the actual conditions for that media at the time of sampling. For instance, the groundwater sampling locations were spatially distributed in a manner likely to produce data reflecting actual concentrations whereas the soil sampling was designed to only evaluate "hot spots" expected to be contaminated. This information was then used to define the immediate and long-term data needs at the site. The results of this evaluation indicated that the groundwater, surface water, and sediment samples could be considered representative of actual conditions at the time of sample collection and that the surface water, sediment, and soil data could be considered representative of baseline conditions at the site. The evaluation did not indicate any immediate need for additional data collection but did indicate a need for long-term monitoring of groundwater and ambient air conditions in order to establish baseline concentrations at the site.

The public health assessment found no evidence of any current public health or environmental concerns associated with the Lees Lane Landfill Site. The assessment did identify a potential for future concerns resulting from groundwater or gas migration and air contamination from the release of gases through the landfill cover. The public health assessment recommended that long-term monitoring be conducted for groundwater and air, that the gas collection system be maintained as necessary to remain operational, and that "hot spots" soils onsite be covered to prevent public contact.

1.4 Remedial Actions to Date

Three remedial actions have been conducted at the site. Two of these are related to the gas migration problems at the site and the third involved the removal of drums discovered along the Ohio River bank. The site was placed on the National Priorities List (NPL) in 1982.

1.4.1 Purchase of Homes

On March 13, 1975 the Jefferson County Department of Health was notified of the presence of methane gas in the Riverside Gardens residential area adjacent to Lees Lane Landfill. As a result of the explosive levels of methane gas detected, seven families along Putman Street were evacuated by the Jefferson County Housing Authority. Their homes were purchased and the families were relocated by the Housing Authority at a cost of $150,000. The seven families and their Putman Street addresses are:

Robert P. Wessel	6701 Putman Street
Harold and Iva Webster	6703 Putman Street
Nicholas and Alma Neff	6707 Putman Street
Robert and Mary Hopper	6711 Putman Street
Ronald and Mary Lutz	6715 Putman Street

David and Ada Barlow	6718 Putman Street
Jack and Dorothy Weatherford	6723 Putman Street

1.4.2 Disposal of Drums

During a visit to the Lees Lane Landfill Site on February 27, 1980 by personnel of the Kentucky Department of Hazardous Materials and Waste Management (HMWM), approximately 400 drums were discovered. The drums were exposed through eroded soil, approximately 100 feet from the Ohio River bank and on a 10 foot vertical rise above the river.

Through the efforts of the Kentucky Natural Resources and Environmental Protection Cabinet (NREPC), an inventory of drum contents was conducted during February and March of 1980. Of the 400 drums, 300 drums were found empty and in a deteriorating condition; 60 drums contained non-hazardous solidified materials and the remaining 40 drums contained hazardous materials. Five samples collected from a random selection of the 40 drums indicated the presence of 51 different organic compounds in addition to high concentrations of copper, cadmium, nickel, lead, and chromium. Benzene, phenol, and their ethylated derivatives were also identified. The wastes were removed from the drums onsite and transported to the Cincinnati Metropolitan Sewage District (MSD) in Cincinnati, Ohio, for final disposition during September and October of 1981. The remaining non-hazardous drummed materials including the empty containers were buried onsite under a plan approved by the KDNREPC.

1.4.3 Gas Collection System

In October 1980, SCS Engineers installed a gas collection system at the site. The system was installed between the landfill and the levee and consisted of 31 extraction wells spaced 75 feet apart. The gas was sent to a blower house through a common header where it was burned off and vented to the atmosphere.

1.4.4 Ranking on NPL

In accordance with the requirements established under the Comprehensive Environmental Response Compensation and Liability Act of 1980 (CERCLA), the Lees Lane Landfill Site was evaluated by EPA in December, 1982, utilizing the Hazard Ranking System (HRS). The HRS was used to evaluate the relative risk or danger factors existing at the Lees Lane Landfill Site, taking into account the population at risk, the hazardous potential of the substances at the facility, the potential for contamination of drinking water supplies and for destruction of sensitive ecosystems and other appropriate factors.

The Lees Lane Landfill Site overall HRS score was 47.46, which ranked the site in Group 6 on the proposed National Priorities List (NPL). The site received high ranking due to its proximity to the nearest population (300 feet), location in a floodway, the identification of landfilled hazardous waste (chromium and vinyl chloride), and the distance to the nearest well (Riverside Gardens). Additional factors included the distance to surface waters and known quantity of material.

1.5 Overview of Report

The remaining sections of this report will present the results of the investigations described above. These sections include: Section 2.0, Site Features Investigation, Section 3.0, Hazardous Substance Investigation; Section 4.0, Hydrogeologic Investigation; Section 5.0 Surface Water, Sediment and Soil Investigation; Section 6.0, Air/Gas Migration Investigation; Section 7.0, Biota Investigation; Section 8.0, Public Health and Environmental Concerns; Section 9.0, Screening of Remedial Action Technologies; Section 10.0, Development of Remedial Action Alternatives; Section 11.0, Analysis of Remedial Action Alternatives; and Section 12.0, Summary of Alternatives. Supporting data referred to in the text are compiled in a separate Appendices volume.

Section 1.0 of this report discusses the site background information such as the environmental setting, site history and ownership, and the planned use of the site.

Additionally, the nature and extent of the problems and a summary of the investigation are presented.

The Site Features Investigation (Section 2.0) was conducted through a literature review and topographic mapping of the site using aerial photography. The purpose of the investigation was to assemble the information concerning the environmental setting based on physiography and climate, the location of potential receptors based on demography and surrounding land use, and the availability of natural resources based on past and future potential for extraction.

The Hazardous Substance Investigation (Section 3.0) was conducted through the use of the historical photographs provided by the Environmental Photographic Interpretation Center (EPIC), performance of a geophysical survey and field observations during the Remedial Investigation, assembly of information collected during a Congressional Investigation in 1979 concerning waste disposed of in the landfill, and evaluation of samples previously collected at the site. The purpose of the investigation was to assemble the information necessary for the design and planning of remedial actions at the site.

The Hydrogeologic Investigation (Section 4.0) was performed through a literature review, the conduct of a boring program and the installation of five monitor wells and the sampling and analyses of groundwater collected from a monitor network designed to evaluate the presence or absence of contaminants and migration pathways. The purpose of the investigation was to assemble sufficient data for the determination of the nature and extent of groundwater contamination and of potential public health effects from the consumption of contaminated groundwater.

The Surface Water, Sediment and Soil Investigation (Section 5.0) was performed through a literature review, the sampling and analysis of surface water, sediment and soil collected onsite, and the evaluation of flood levels expected at the site over various periods. The purpose of the investigation was to assemble sufficient data for the determination of the nature and extent of surface contamination and the potential public health effects from direct contact with the contaminated surface media.

The Air/Gas Migration Investigation (Section 6.0) was conducted using the results of previous studies performed in 1975 to 1979, monitoring measurements made from 1980 to 1984 and the study performed by IT Corporation as part of the Remedial Investigation. The purpose of the investigation was to determine the nature and extent of the methane migration at the site both before and after the installation of the gas collection system and the potential for public health effects in Riverside Gardens associated with combustible levels of methane or toxic levels of other volatile organic compounds.

The Biota Investigation (Section 7.0) was conducted through a literature review only. The purpose of the investigation was to identify the flora and fauna expected at the site as well as the endangered species that might be present at the site. This information was assembled for use in the environmental assessment.

The Public Health and Environmental Concerns (Section 8.0) at the site were identified through the evaluation of the potential contamination present, and the human and environmental effects of contaminant migration. A toxicological evaluation of the contaminants was used to determine the potential health effects.

The Screening of Remedial Action Technologies (Section 9.0) was used to identify the most appropriate remedial action technologies. Each technology was screened for its technical considerations, public health and environmental considerations, institutional considerations, and costs.

Development of Remedial Action Alternatives (Section 10.0) included the detailed description and design for each identified alternative and the reasons for eliminating other alternatives.

The Analysis of Remedial Action Alternatives (Section 11.0) includes an evaluation against non-cost and cost criteria. The non-cost criteria include technical, public health, environmental, and institutional considerations.

The Summary of Alternatives (Section 12.0) compares the alternatives in narrative and tabular form and defines the advantages and disadvantages of each alternative.

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2.0 SITE FEATURES INVESTIGATION

The site features investigation gives an overview of the physical conditions, land use, and climate on and around the site. The investigation was accomplished through a review of pertinent available literature.

2.1 Physiography

The site is located in the Ohio River Terraces region, which occurs on the southwestern flank of the Cincinnati arch in the eastern part of the Interior Lowlands physiographic province. This province is characterized by sedimentary rocks of Cambrian to Cenozoic age. The rocks in the eastern portion of the province are mainly Paleozoic limestones and shales. The northern portions of the province were covered by continental ice sheets during the Pleistocene; the Lees Lane Landfill Site is situated in an extensive glacial outwash plain deposited over the Paleozoic bedrock as the glacier retreated (Judson, et al., 1976). The relatively flat, rather hummocky topography of the site area is characteristic of outwash plains (see Figure 2-1). The Ohio River is an underfit stream crossing the outwash plain; it probably served as a glacial meltwater stream during late Pleistocene glacial retreat. (Bloom, 1978; Ritter, 1978).

The site topography has been disturbed by quarrying and landfilling operations. No drainage pathways cross the landfill, however, a topographic low in the Northern Tract may aid in the diversion of surface water runoff from a small area in this tract to the Ohio River. There are also two depressions in the Southern Tract resulting from remaining landfill capacity after closure. One of these depressions is water-filled and receives runoff from approximately one-half of the Southern Tract. Figure 2-2 shows current site topography.

2.2 Demography

The site is located in west central Jefferson County, approximately 4.4 miles southwest of downtown Louisville. The population growth of Jefferson County has been modest but gradual. The greatest rate of growth occurred in the decade of the 1950's with an annual rate of change of 2.6%. This decade marked the

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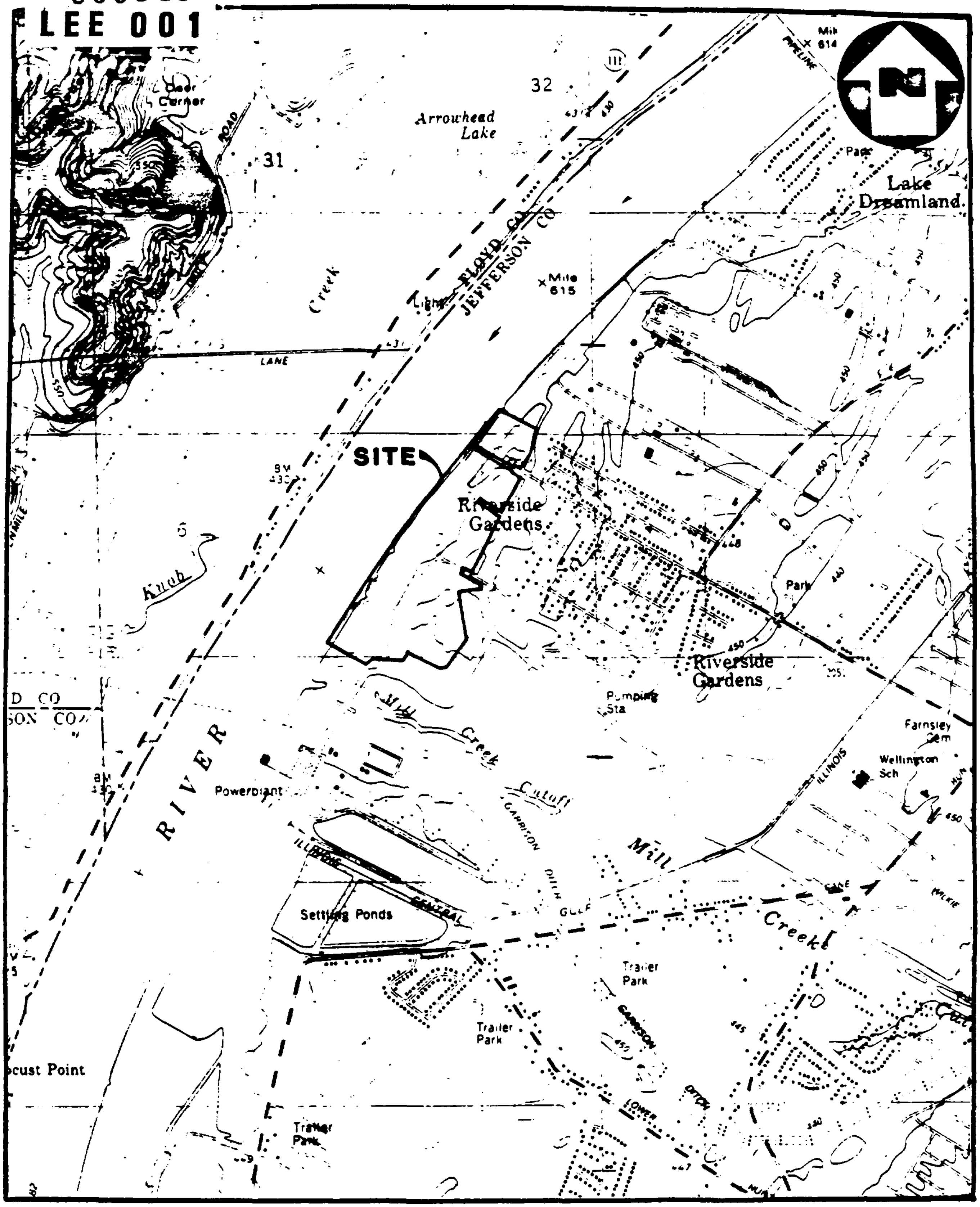
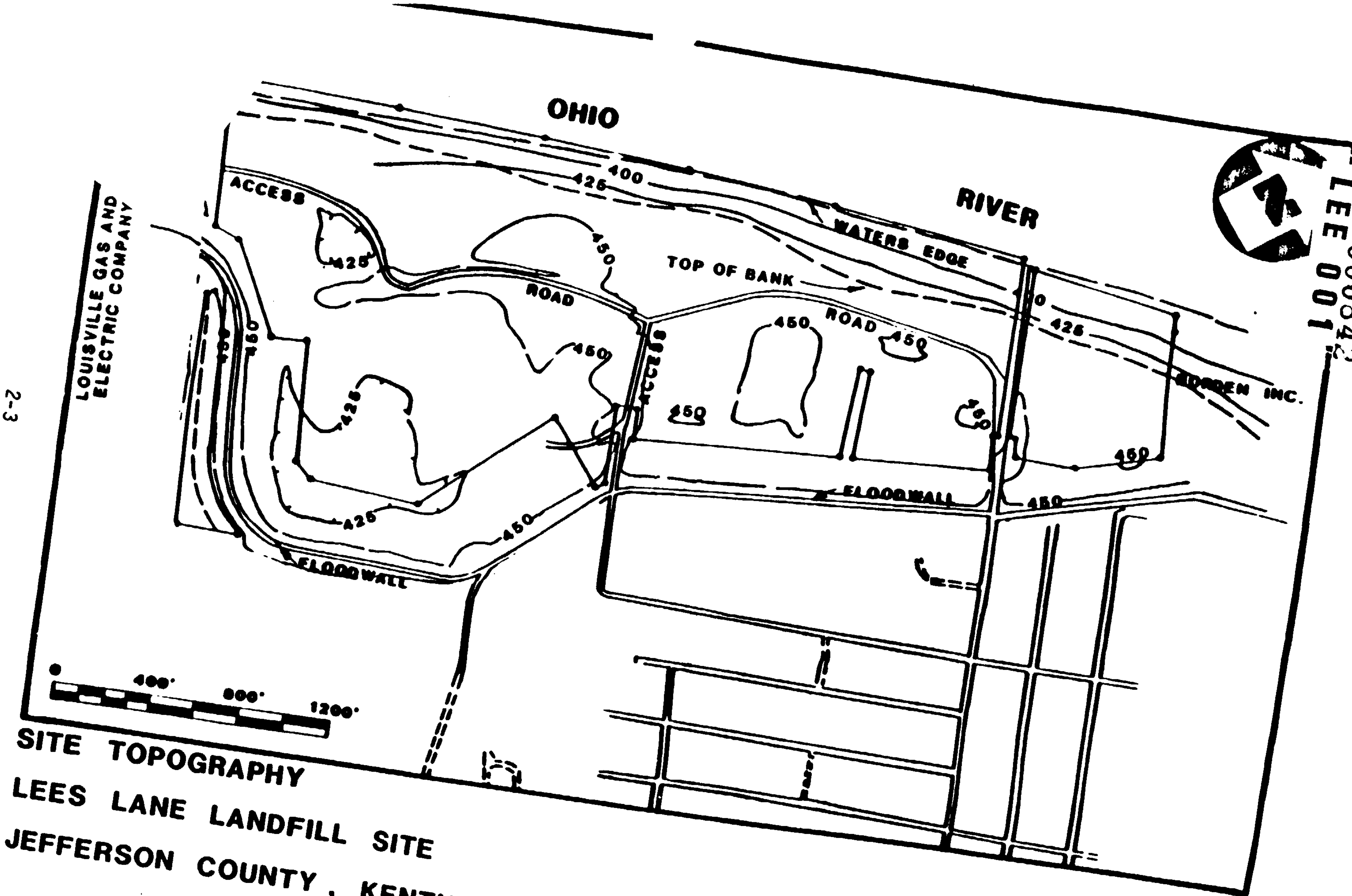


BASE MAP IS A PORTION OF THE U.S.G.S. 7.5 MINUTE QUADRANGLE
LOUISVILLE WEST, KY.-IND. 1960 & LANESVILLE, IND.-KY. 1971

FIGURE 2-1

TOPOGRAPHY OF SITE AREA
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

NUS CORPORATION
A Halliburton Company



SITE TOPOGRAPHY
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

FIGURE 2-2

NUS CORPORATION
A Halliburton Company

beginning of migration from the City of Louisville to the balance of Jefferson County. By the 1960's, the rate of growth had declined to a rate of 1.4% per annum with population continuing to shift from the central city to the suburbs. By 1975, Jefferson County had a population of 735,000 people, with the City of Louisville containing 347,252 of the total county population. (KIDPA, 1978).

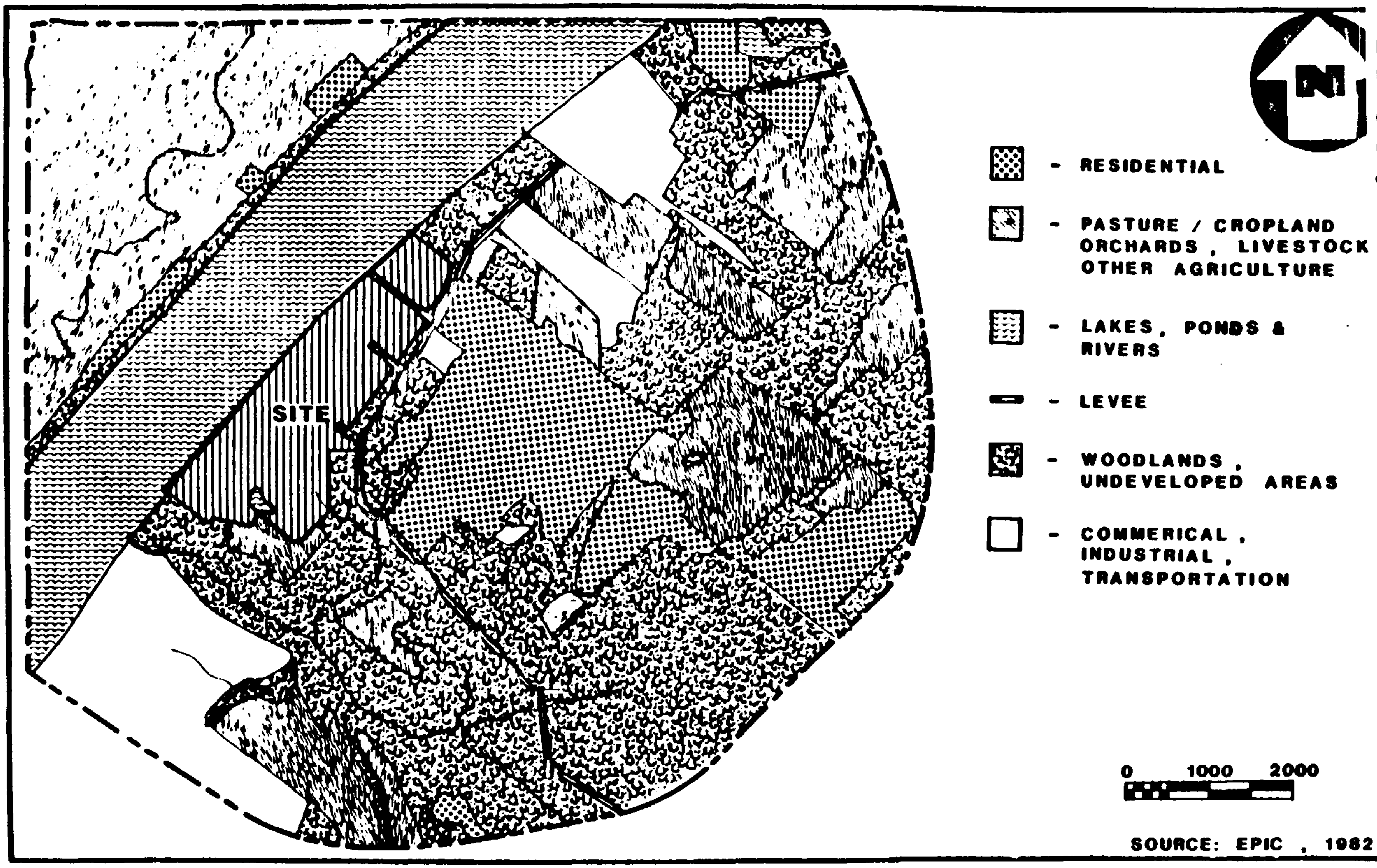
The concentration of population nearest the landfill is Riverside Gardens, a residential area which is adjacent to the landfill. Riverside Gardens consists of approximately 330 homes and 1,100 people. (NUS Corp., 1983a).

Another subdivision, Lake Dreamland, is located approximately 1.5 miles upstream from the site and has a population of approximately 1,500 people. A residential area of approximately 50 homes is located across the Ohio River from the site. Figure 2-1 indicated the Lake Dreamland and Riverside Gardens subdivisions and their proximity to the site.

2.3 Land Use

EPIC aerial photography with 1971 land use designations (Figure 2-3) was used to calculate the amounts of each class of land use within a 1.2 mile radius of the Lees Lane Landfill (EPA, 1982). The greatest percentage of land (38%) is woodlands and undeveloped areas, followed by agricultural land at 33%. Residential land comprises 15% of the area surrounding the landfill and land used for commercial, industrial, and transportation totals 14% of the area. Lakes, ponds, streams, and wetlands exclusive of the Ohio River comprise less than 1% of the land within the 1.2 mile radius.

The Lees Lane Landfill is bordered to the northeast by Borden, Inc. (a chemical manufacturer), to the south by Louisville Gas and Electric (a power plant), and to the east by Riverside Gardens (a residential development). A floodwall right-of-way fringes the property line to the west of Riverside Gardens, where the levee serves as a managed buffer zone between the landfill and the adjacent residential development. Portions of the west side of the site have a relatively undisturbed area which serves as a buffer zone between the landfill and the Ohio River.



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LAND USE MAP
LEES LANE LANDFILL SITE
JEFFERSON COUNTY , KENTUCKY

FIGURE 2-3

NUS CORPORATION
A Halliburton Company

The landfill currently serves as a recreational area for local residents. The site is popular as a hunting ground for birds and small game, and for target practice. Additionally, many residents visit the site daily to walk their dogs.

2.4 Natural Resources

Jefferson County has many natural resources. Sand and gravel for aggregate, fill and road metal are excavated from the glacial outwash plain deposits of the Ohio River Valley. Quarrying operations were conducted at the site prior to and during its use as a landfill. Natural gas for domestic use has been obtained from at least two wells within ten miles of the site which are now abandoned (Kepferle, 1974). The New Albany Shale has been explored throughout its outcrop and subsurface area for its potential as oil shale, but exploitation is currently economically infeasible, therefore no development has occurred (Anderson, pers. comm., 1985).

Dimension stone has been quarried in the past from the siltstone beds of the Kenwood Siltstone Member of the Borden Formation. These quarries were located within ten miles of the site. No commercial quarries are currently active (Kepferle, 1974).

Groundwater has been a historical natural resource of the site area, with approximately 14 wells used for drinking water supplies in Riverside Gardens prior to the installation of a city water supply system. (E & E, 1981). In 1984, only eight drinking water supply wells remained in service. The inventory of private well supplies in Riverside Gardens conducted by Ecology and Environment (E & E) in 1981 and as supplemented during the Remedial Investigation is included in Table 2-1. The locations of four of these homes are shown in Figure 2-4. The remaining four homes on Glenbrook Avenue and Flagler Street are off of the map on Figure 2-4.

The surface water resources of the Ohio River Basin are extensively used for a variety of purposes including transportation, recreation, municipal and industrial water supply, cooling for energy production, wildlife habitat, agriculture, and assimilation of waste. There are 18 municipal and industrial surface water users of the Cannelton Pool which is located between the Cannelton Dam (at River Mile (RM) 722) and McAlpine Dam (at RM 607) (see Table 2-2). The majority of these intakes are upstream of the Lees Lane Landfill. The closest known downstream

TABLE 2-1
RESIDENTIAL WELL INVENTORY
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Well Owner	Address	Well Use	Map Reference
Mr. James Salleng*	6614 Lucerne St.	N/U	LU-614
Mr. James Mann	6604 Lucerne St.	N/U	LU-604
Riverside Baptist Church	4317 Lees Lane	drinking	RBW-1
Mr. Williamson	6618 Melrose St.	gardening	ME-618
Mr. Ray Wright	6616 Melrose St.	N/U	ME-616
Mr. Elvis White	6603 Melrose St.	gardening	ME-603
Mr. Lowell Wright	6519 Putman St.	N/U	PU-519
Mr. William Hayburn	6503 Putman St.	N/U	PU-503
Mr. Morris Parker	4405 Lees Lane	N/U	LE-405
Mr. Martin Faircloth	4416 Lees Lane	drinking	LE-416
Mr. T. O. Frankie	4416 Wilshire Blvd.	gardening	WL-416
Mr. Ashley	4408 Wilmoth Ave.	N/U	WM-408
Mr. Cecil Simpson	6508 Howard Ave.	drinking	HO-508
Mr. Joseph Downs	4422 Wilmoth Ave.	N/U	WM-422

Source: E & E, 1981.
N/U - Not in use.

* Mrs. Pat Moran, head of the Riverside Gardens Community Council, informed EPA in March 1986, that the house of 6614 Lucerne Street was currently owned by Tammy Blarr, and that the well at this location was being used for water supply. In addition, Mrs. Moran identified the following additional homes as having a well being used for water supply:

Lester Rose	6615 Glenbrook Avenue
Thomas Ziegler	6707 Glenbrook Avenue
Wallace Morton	6713 Flagler Street
Maria Torrance	6719 Flagler Street

TABLE 2-2

WATER INTAKES
OHIO RIVER REACH
LOUISVILLE TO CANNELTON DAM

Mile Point	Water Company or Industry	Location
594.5	Louisville Water Co. (MI)	Louisville, KY
600.6	Louisville Water Co. (MI)	Louisville, KY
603.6	Louisville G & E Co., Waterside Station	Louisville, KY
603.6	Colgate Palmolive Co.	Jefferson, IN
604.9	Louisville G & E Co., Canal Station	Louisvile, KY
609.0	Indiana Cities Water Co. (MI)	Falls City. IN
610.0	Public Service of Indiana - Gallagher	New Albany, IN
612.6	National Carbide Corp.	Louisville, KY
612.9	Louisville G & E Co., Paddys Run Sta.	Louisville, KY
613.5	E.I. du Pont de Nemours & Co.	Louisville, KY
613.5	Publicker Chemical Co. (Rohm & Haas)	Louisville, KY
616.6	Louisville G & E Co., Cane Run Station	Louisville, KY
620.6	Indiana Glass & Sand Co.	Harrison Co., IN
625.9	Louisville G & E Co., Mill Creek	Louisville, KY
627.0	Kosmos-Portland Cement Co.	Kosmosdale, KY
643.4	Olin Corp.	Brandenburg, KY
644.0	Olin Corp.	Brandenburg, KY
654.1	Kosmos-Portland Cement Co.	Brandenburg, KY

Note: Lees Lane Landfill is between River Mile 615 and 616.
Source: Ohio River Valley Water Sanitation Commission, 1977.

intake for a public drinking water supply is located at West Point, Kentucky, approximately 14 miles downstream from the site.

2.5 Climatology

The climate of Louisville is continental in type and varies seasonally due to its position in the midlatitudes. Summers are quite warm, but temperatures rarely exceed 100° F. Rainfall is relatively evenly distributed throughout the year, with the spring and summer receiving slightly higher amounts of precipitation. Thunderstorms with high winds and high intensity rainfall account for the majority of the monthly precipitation. The fall generally receives two to three inches of rain per month, making it the driest season of the year. Normal annual precipitation is 44 inches per year (NOAA, 1978).

Winters are moderately cold in the Louisville area, with temperatures rarely dipping below 0° F. Snowfall, while seldom heavy, is a usual occurrence during the winter months November through March. The mean annual total snowfall is 12 to 24 inches per year (NOAA, 1978). Soil freeze conditions, which vary according to local weather, generally occur throughout December, January, and February. The average soil freeze depth is five to eight inches, although depths of 12 to 14 inches have occurred during prolonged periods of extremely cold weather. Conversely, shallower soil freeze depths have occurred during warmer-than-normal winter weather (Crenshaw, pers. comm., 1985).

The prevailing wind direction in the area has a southerly component and an average velocity of less than ten miles per hour, as illustrated by the wind rose diagram, Figure 2-5. The strongest winds are usually associated with spring and summer thunderstorms. (NOAA, 1978; 1983).

2.6 Site Features Summary

The Lees Lane Landfill Site is bordered on the northeast by Borden, Inc. (a chemical manufacturer), to the south by Louisville Gas and Electric (a power plant), Riverside Gardens to the east, and a small residential development (50 homes) across the Ohio River. Approximately 370 employees work at the adjacent industries, while 1,100 people live in the Riverside Gardens area.

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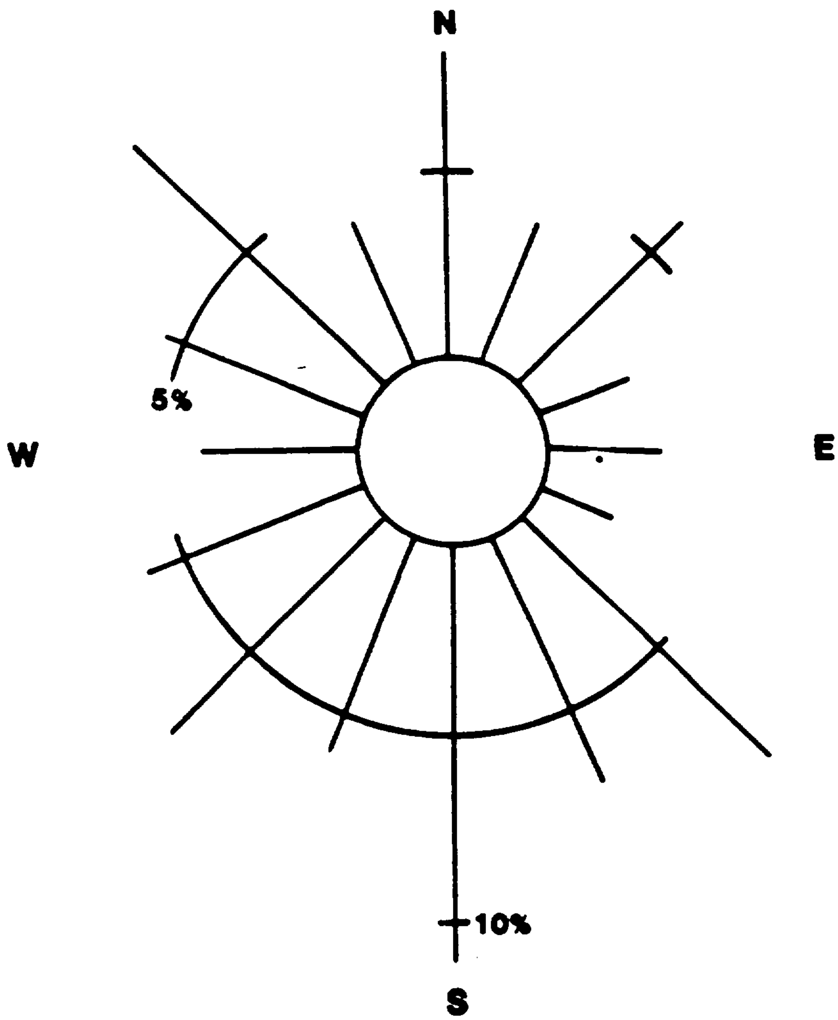


NOTE : LENGTH OF LINE CORRESPONDS TO PERCENTAGE OF TIME WIND BLOWS FROM THE INDICATED DIRECTION

SOURCE : NOAA, 1983

FIGURE 2-5

WIND ROSE
LEES LANE LANDFILL SITE
JEFFERSON COUNTY , KENTUCKY

NUS CORPORATION
A Halliburton Company

LEE 001

000850

Only eight private wells within the Riverside Gardens residential area are used for potable water. The Edwardsville Water Company, located in Indiana, obtains raw water from wells located along the river. The Edwardsville Water Company supplies potable water to 1,700 connections, in addition to supplying two other water companies.

Although the site is private property, it is used by some residents for hunting, target practice, and walking pets.

3.0 HAZARDOUS SUBSTANCE INVESTIGATION

The hazardous substance investigations focused on the potential pathways of contaminants and attempted to ascertain the estimated volumes and location of fill materials. The information for this section was compiled from a variety of sources including historical records and aerial photographs. The results of several investigations were used to determine the extent of landfilling operations.

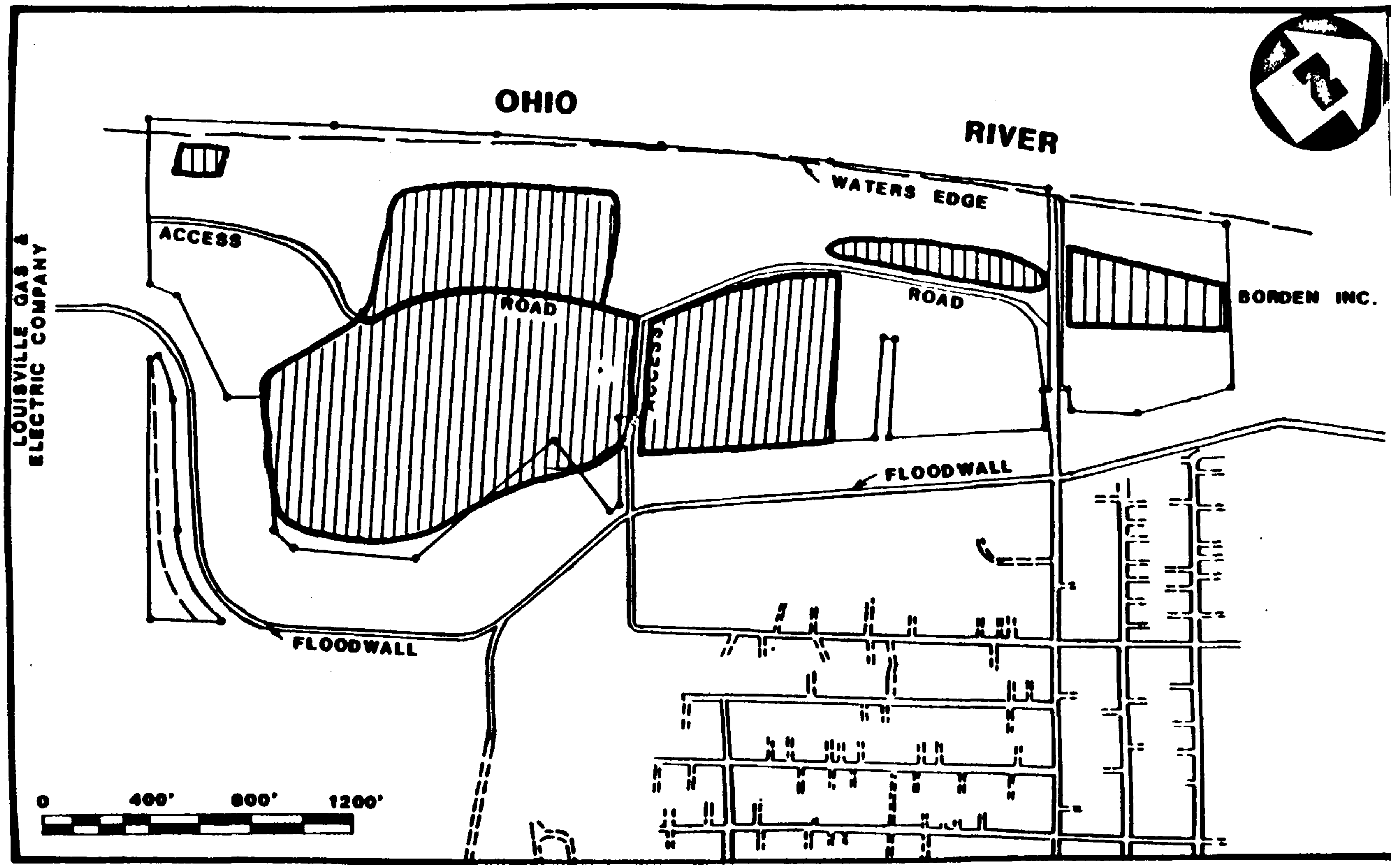
3.1 Landfill Operations

Land use at the Lees Lane Landfill Site has included a sand and gravel quarry, a junkyard and a landfill. The period of sand and gravel operations at the site is not known, but quarrying began at least as early as the 1940's. Figure 3-1 is a sketch made from historical aerial photographs (EPIC, 1982) and existing topography that indicates the approximate areas that were excavated during the existence of the landfill.

The landfilling operations at the site were reported to have begun in the late 1940's. Based on available historical photographs, refuse and old automobiles were observed in the Central Tract in 1955; active refuse disposal was observed in the Central Tract in 1959; and fill and active disposal were observed in the Southern Tract in 1971 (see Figure 3-2).

From the aerial photographs fill operations appear to have been initiated as open dumping along the Southern and Central Tracts of the property. Dumping, in all likelihood, also occurred in the open sand and gravel pits during this same time period. Open dumping at the front of the property stopped sometime during the 1960's and all dumping was then limited to the sand and gravel pits.

Aerial photographs taken on March 30, 1971 show that extensive excavation and fill operations were being conducted. Fill areas were located in the Central and Southern Tracts and excavation areas in the Northern and Southern Tracts. Background information for the site indicates that the Northern Tract excavation area was eventually filled with wastes but that the site was closed before the excavation area in the Southern Tract was completely filled. A large depression with ponded water now exists in the Southern Tract.



LEE 001 000852

EXCAVATED AREAS

EPIC AERIAL PHOTOGRAPH - MARCH 1971

LEES LANE LANDFILL SITE

JEFFERSON COUNTY, KENTUCKY

FIGURE 3-1

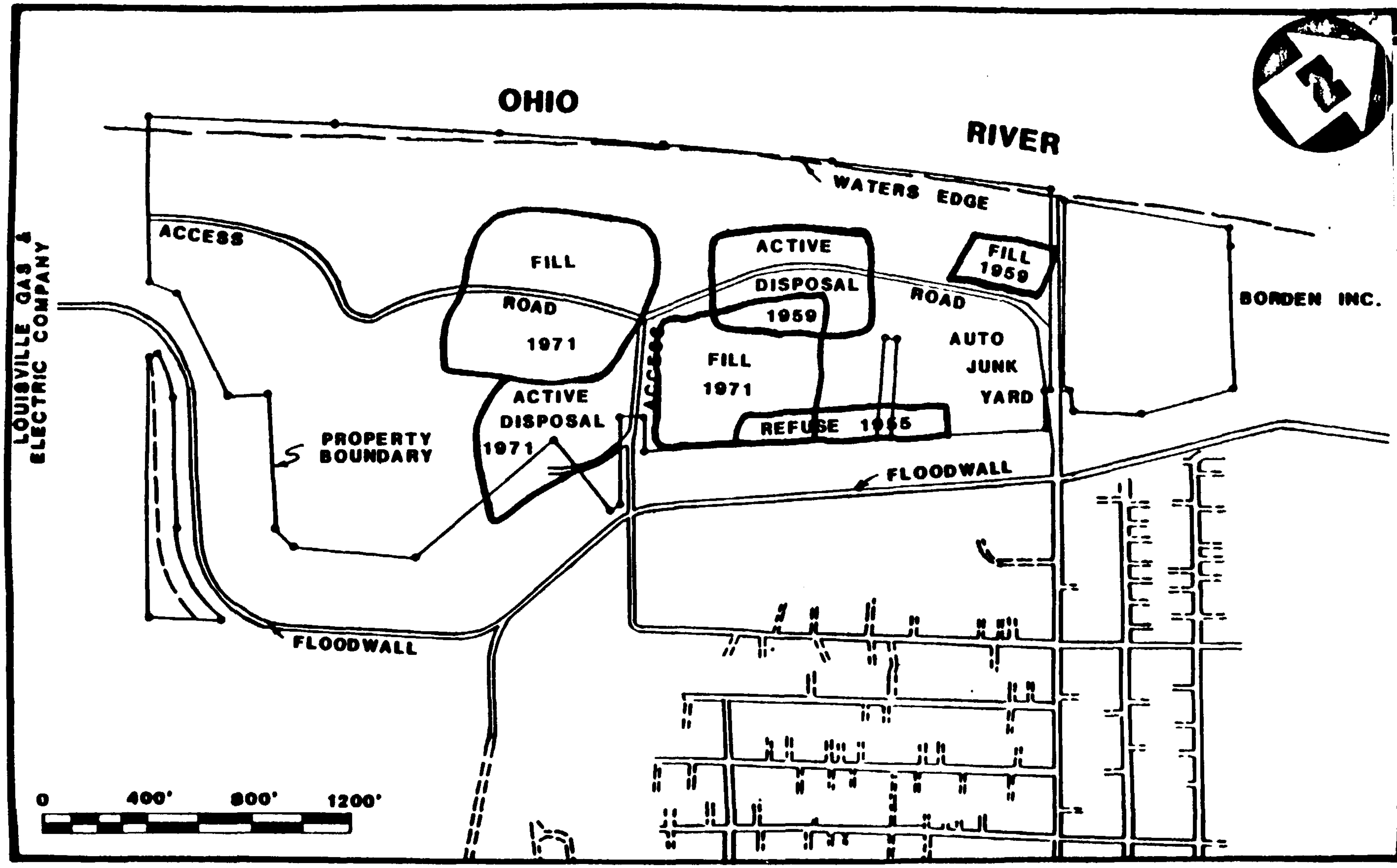
LEGEND

EXCAVATED AREAS

NUS CORPORATION

A Halliburton Company

LEE 001 000853



FILL / DISPOSAL AREAS
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

LEGEND

– FILL AREAS AND ACTIVE DISPOSAL AREAS FROM AERIAL PHOTOGRAPHS 1955 – 1971

FIGURE 3-2

NUS CORPORATION
A Halliburton Company

The available information indicates that most of the excavated areas were eventually used for refuse or waste disposal. Since historical records of disposal practices at the site are not available, it is believed the landfill was formed by random dumping of various wastes into open pits created by sand and gravel mining operations. There is no evidence that drums were segregated in trenches or individual pits or that municipal solid wastes were deposited in cells.

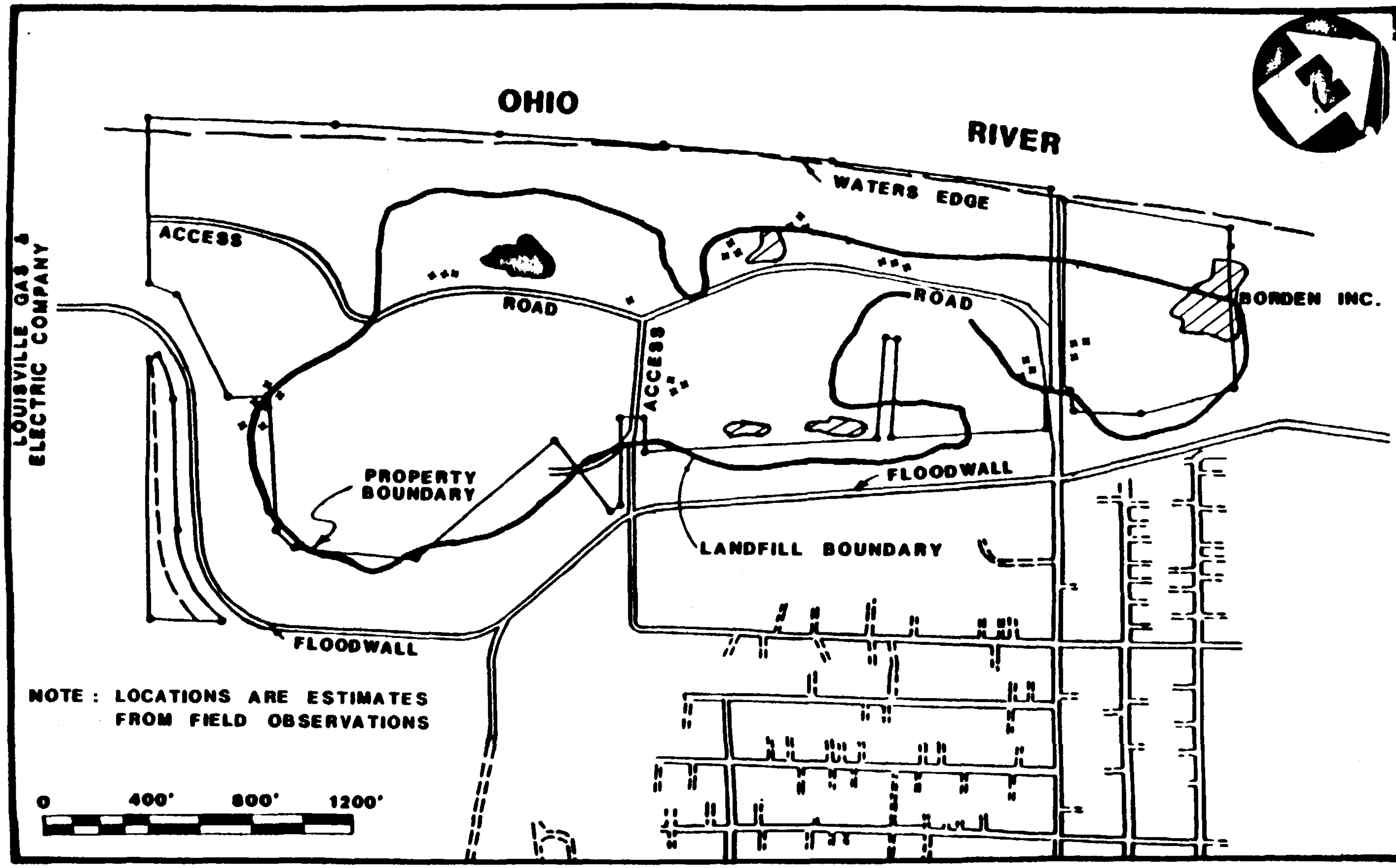
3.2 Waste Location

Information and data on the physical composition of wastes disposed of in and around the landfill is important in the selection and operation of removal equipment and facilities, in assessing the feasibility of resource and energy recovery, and in the analysis and design of ultimate disposal technologies. Very little information is available on the quantities and types of waste disposed of at the Lees Lane Landfill. Waste has been observed on the landfill surface at the site.

3.2.1 Surface Waste

Observations made during the conduct of the RI suggest that indiscriminate dumping is still occurring on a small scale at the landfill. This is due, in part, to unrestricted access at the site as well as heavy vegetation which obscures the dumping. The useable access roads facilitate dumping and it should be expected that local residents will continue to use the site for the disposal of household wastes. Figure 3-3 delineates approximate areas where waste has been observed at the site. These wastes include large appliances, scrap wood and furniture, and are scattered over much of the landfill surface. In most cases, these materials were located near the landfill access roads.

In addition to the disposal of household wastes on the landfill surface, some industrial wastes have also been indiscriminately dumped since official closure of the landfill in 1975 (see Figure 3-3). Probable post-closure landfill use by industry is evidenced by the drums discovered along the Ohio River bank in early 1983. These drums are located near the landfill boundary of the Southern Tract along the river bank and were observed again during RI activity conducted in 1984. In 1983, during a FIT site reconnaissance, heavy organic odors were noticed in the areas



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SURFACE WASTE AREAS (1984)
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

LEGEND

- DRUMS
- OTHER WASTE
- 1983 DRUM LOCATION

FIGURE 3-3

NUS CORPORATION
A Halliburton Company

surrounding these drums and a black liquid was apparently leaking from one of the drums. Since the contents of these drums have not been analyzed, it will be assumed for costing purposes in the Feasibility Study that they contain hazardous wastes.

Also shown in Figure 3-3 are several areas of surface waste and partially or fully exposed drums. The areas along the Ohio River bank are exposed waste believed to be the product of poor disposal practices and not the result of erosion of filled areas. Based on available information and visual observation, the surface wastes and drums located along the bank are the result of disposed waste being pushed over the retaining wall and, subsequently, covered by the river sediments.

Besides visible drums in the Southern Tract, several areas of surface waste were observed. Drums have been observed scattered throughout the entire landfill area. Some of the drums have been crushed and most of the drums show signs of rust and deterioration. Many of the surface waste areas and drums shown on Figure 3-3 are obscured by vegetation much of the year. The wastes and drums do not appear to be eroding out of the landfill, but are the result of either dumping after the landfill was closed or improper coverage during landfill closure.

3.2.2 Ferromagnetic Waste

Magnetometer methods were used at the Lees Lane Landfill Site to locate areas of buried drums and/or ferromagnetic debris along the river bank, and for determining the boundary of the fill. These techniques provide a cost-effective and safe means for determining landfill boundaries assuming the anomalous areas correspond to buried ferromagnetic materials.

The instrument used for the current study was an EG & G Geometrics, Model 846, total-field magnetometer. The magnetometer was used instead of an electromagnetometer (EM) to allow for easier maneuverability. The vegetation which grows onsite is very heavy and dense near the river and the EM is 10 feet long while the magnetometer is only 2 feet long. The use of the smaller, more manageable magnetometer allowed the survey crew to reach some data points which would have otherwise been inaccessible.

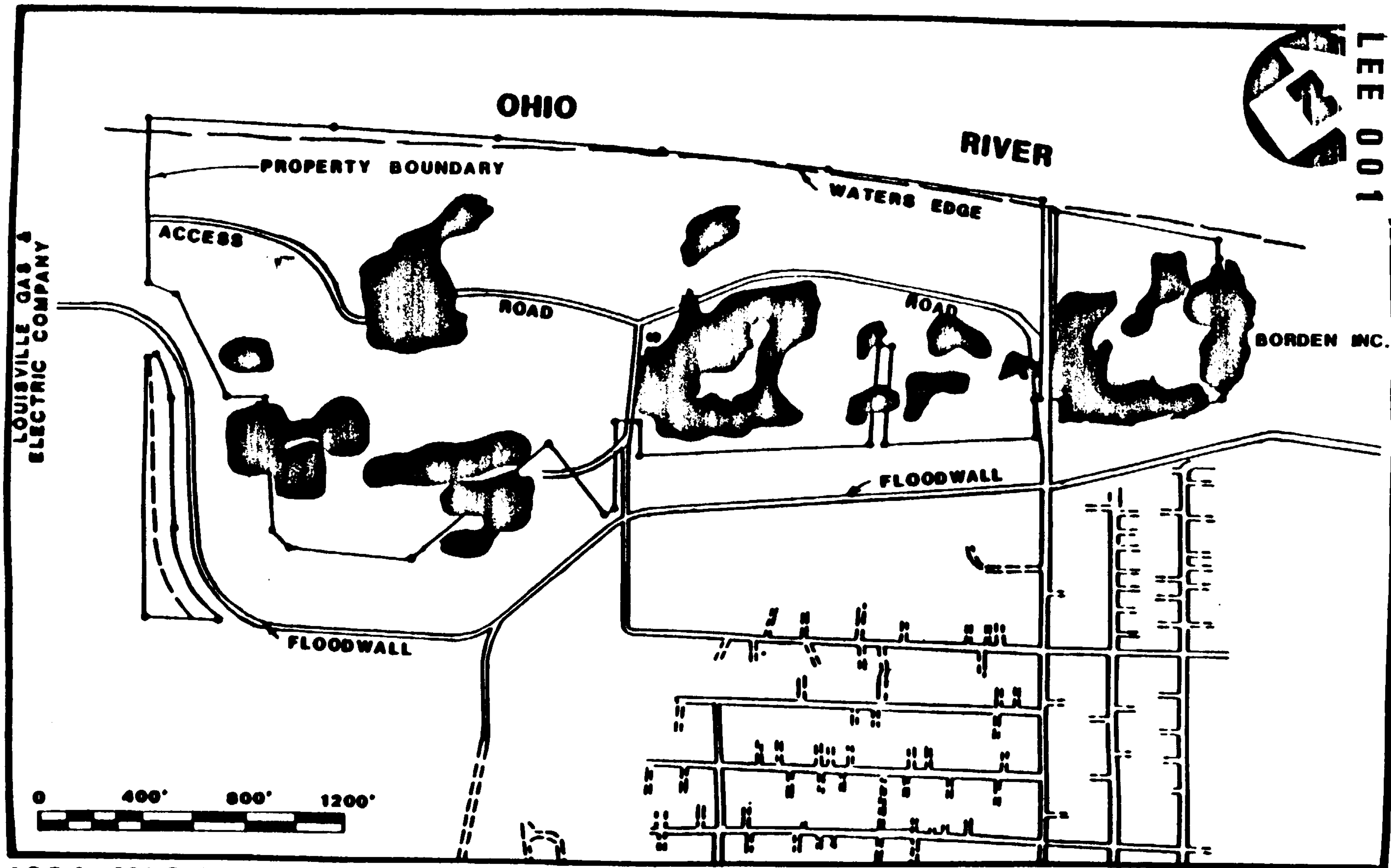
3.2.2.1 Fill Boundary Investigation

A magnetic survey was performed over the Lees Lane Landfill Site to investigate the extent of buried ferromagnetic materials. Readings were collected over two 50-foot centered grids and one grid with data points of 50 by 200-foot intervals. The investigation was divided into four separate grids to make the surveys more manageable in size. Once obtained, the background magnetic intensity of 56,250 gammas was subtracted from each reading and a contour map of the spatially distributed data was prepared. The contours of this map represent anomaly strength in intervals of 400 gammas.

Several large anomalies of up to 4000 gammas occur at the southeastern section of the site and away from the river. There are also several anomalies of 800 to 1200 gammas which occur along the river side of the Central Tract of the site. These anomalies are isolated and therefore are suspected to originate from independent metallic sources as opposed to the anomalies in the Northern and Southern Tracts of the site which appear to originate from combined sources. This combined interference makes it difficult to discern an exact locality of the metallic source or sources.

The magnetic anomalies derived from the RI data represent areas of magnetic intensity greater than 800 gammas above background and are shown in Figure 3-4. This data compares favorably with that collected in May of 1982 by Ecology & Environment, Inc. (E & E) (see Figure 3-5). The shaded areas from the E & E data represent ferromagnetic material with magnetic intensity greater than 57,000 gammas (or 750 gammas above background of 56,250 gammas).

The fill area as defined by the magnetic data is contained within the floodwall to the east and southeast and by the river to the west and northwest. The fill appears to be absent in the southwest corner of the site.



1984 MAGNETOMETER SURVEY

LEES LANE LANDFILL SITE

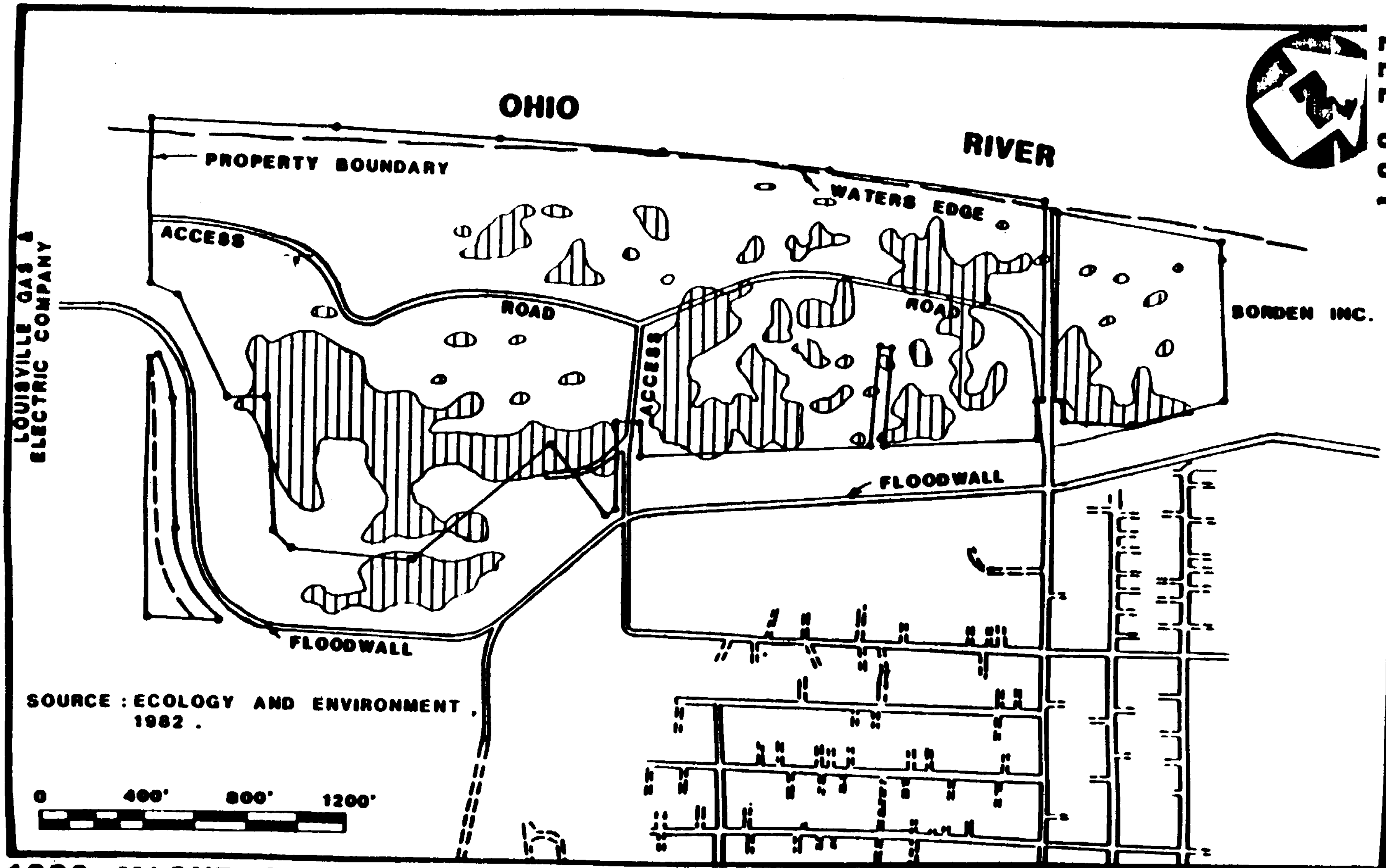
JEFFERSON COUNTY, KENTUCKY

LEGEND

– AREAS OF MAGNETIC FIELD INTENSITY GREATER THAN 57,000 GAMMAS

FIGURE 3-4

NUS CORPORATION



1982 MAGNETOMETER SURVEY
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

LEGEND

- AREAS OF MAGNETIC FIELD INTENSITY GREATER THAN 57,000 GAMMAS

FIGURE 3-5

NUS CORPORATION

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3.2.2.2 Bank Investigation

A magnetic survey was also performed in the area along the river bank to locate any buried drums or ferromagnetic debris and to determine if the drums exposed at the surface were originally placed on the upper terrace or buried and then exposed by erosion. Readings were collected over a 50-foot centered grid and then the background magnetic intensity of 56,250 gammas was subtracted from each reading and the spatially distributed data was contoured.

The majority of the exposed drums in the Central Tract are located on the upper terrace and toward the river side of the access road. The anomalies in this area are believed to be a result of these exposed drums and not buried ferromagnetic material. The anomalies which occur near the river and in the Northern Tract of the site are mostly the result of exposed ferromagnetic debris (washing machines, cans, scrap metal, etc.).

It would appear that the drums were originally placed on the surface of the upper terrace and not buried. Careful examination of the drums suggests that some of the drums may have rolled down from the upper terrace to the lower areas. These drums are believed partially covered by soils from areas above the drums and/or were accidentally covered during landfilling operations. Visual observation of solid waste debris along the bank suggests that the landfill retaining wall abutting the river bank is not severely eroding, although some erosion is occurring.

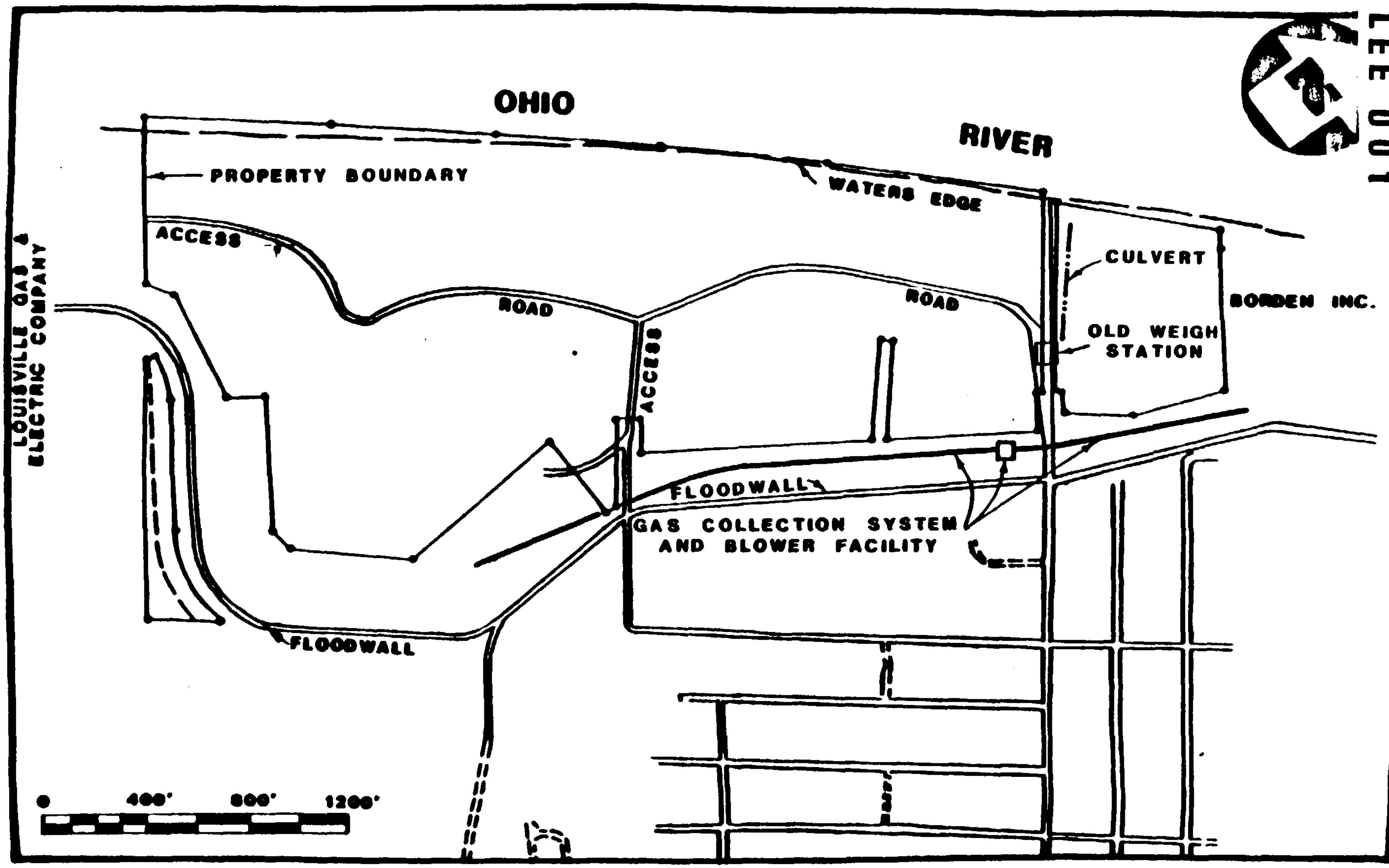
3.2.3 Extent of Fill

The extent of the potential areas of fill material (horizontally and vertically) has been roughly estimated using pertinent information gained through the Remedial Investigation. This information will form the basis for the approximation of the volume of waste and contaminated materials currently existing at the site. This approximation is useful only in the evaluation of the feasibility of excavation of the waste materials.

Several structures exist at the site which may affect remedial operations (see Figure 3-6). A gas collection system was installed underground in an area between the landfill and the floodwall. The system contains a surface blower facility adjacent to Lees Lane. Also, located onsite is the old weigh station used during the operation of the landfill. Finally, a concrete culvert is shown to run semiparallel to Lees Lane. At least two surface manholes aid in locating the culvert.

The area of the landfilling operation has been defined as the outer limits of in-place waste disposal. It does not include those areas along the Ohio River where waste has apparently been deposited on the river bank and partially covered by sediments. The approximate boundary of landfilling operations is shown in Figure 3-7. As can be seen, the boundary parallels the floodwall to the south and southeast and the access road to the northwest along the Ohio River. More importantly, it appears likely that the landfill operations may have crossed property boundaries. This landfill boundary has been estimated, independent of the property boundary survey, by comparing the results of both magnetometer studies with the excavated areas identified by the Environmental Photographic Interpretation Center (EPIC) in their interpretation of the historical photographs for the site. It should be recognized that since the landfilling operation was predominantly one of filling the areas previously excavated for sand and gravel, the area within the landfill boundary is not expected to contain continuous wastes but instead pockets of wastes corresponding to the original sand and gravel pits. The landfill boundary will be used to evaluate the effects of various Ohio River flood levels on the landfill (see Section 5.1.3) as well as to approximate the volume of waste.

There is only limited information concerning the depth of fill at specific locations within the landfill. The available refuse depths presented in Table 3-1 support the current understanding that the depth of fill is extremely varied throughout the site. (See Figure 3-8 for boring locations) This variability is to be expected, considering the nature of the sand and gravel excavation performed at the site, but suggests that additional borings to confirm the depth of refuse at specific locations would be meaningless. It is unlikely that the depth of waste disposal in any one pit would be uniform since the excavation of that pit was probably not uniform.



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SITE STRUCTURES

LEES LANE LANDFILL SITE

JEFFERSON COUNTY, KENTUCKY

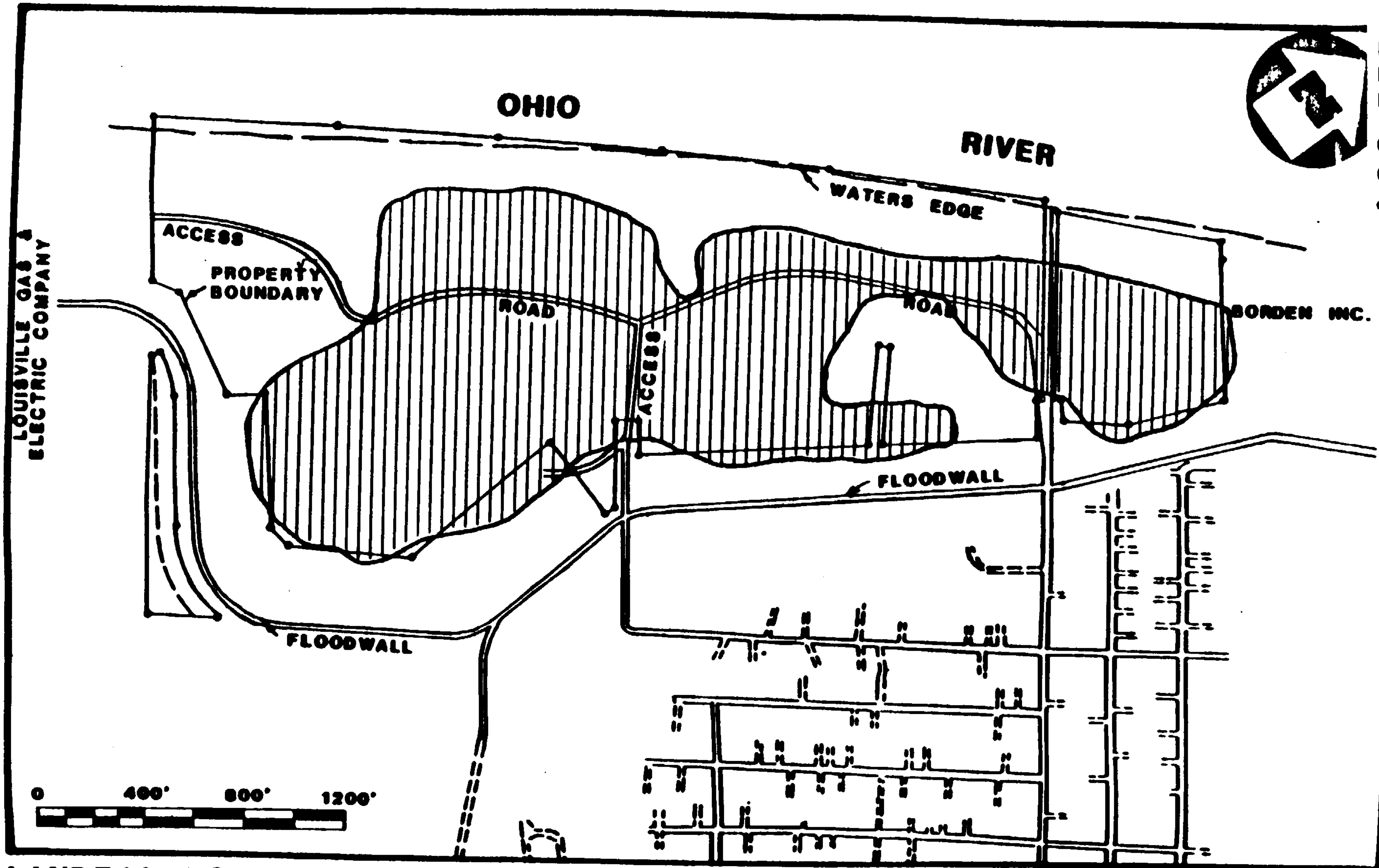
FIGURE 3-6

NUS CORPORATION

A Halliburton Company

TABLE 3-1
AVAILABLE REFUSE DEPTHS
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Well Boring	Well Type	Installation Date	Boring Depth (Feet)	Refuse Depth (Feet)
IV-0	gas	1978	41.5	37
IV-1	gas	1978	36.5	29
IV-2	gas	1978	25.5	19
IV-3	gas	1978	30.5	20
IV-4	gas	1978	30.5	25
MW-04	groundwater	1984	91.0	20



LANDFILL BOUNDARY
LEES LANE LANDFILL SITE
JEFFERSON COUNTY , KENTUCKY

FIGURE 3-7

NUS CORPORATION
A Halliburton Company

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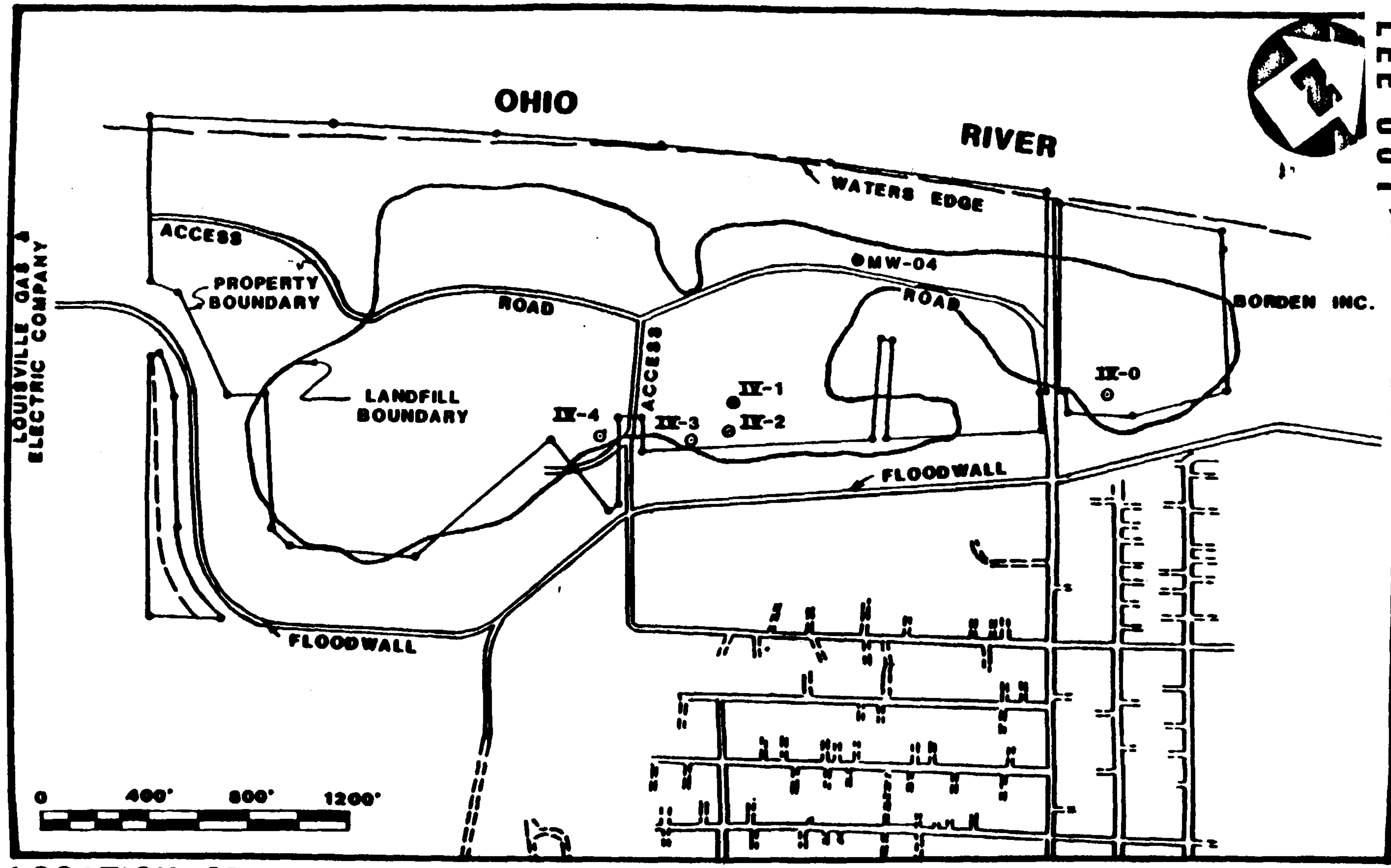


LOCATION OF AVAILABLE
REFUSE DEPTHS
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

LEGEND

● - NUS GROUNDWATER MONITOR WELL (INSTALLED 1984)

● - PHASE IV GAS MONITOR WELL (INSTALLED 1978)

FIGURE 3-8

NUS CORPORATION
A Halliburton Company

LEE 001 000865

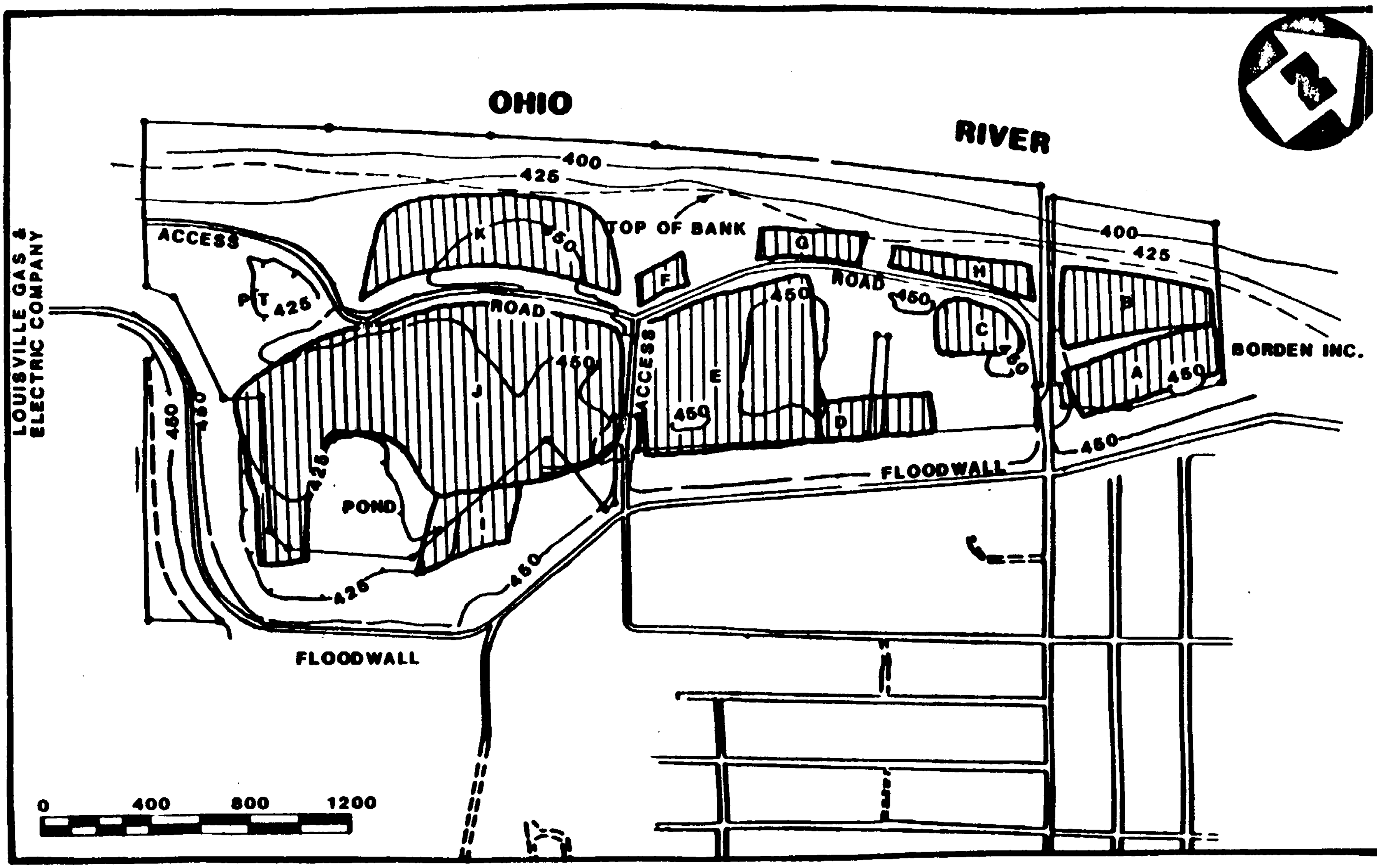
Therefore, a single estimate of the depth of fill at the site has not been made since such an average would be very misleading. Where depth of fill was necessary to approximate the fill volume, specific estimates were made for each identified portion of the landfill. Again, these estimates are only significant in that the overall approximate volume of waste at the site will be used to evaluate the feasibility of landfill excavation.

3.3 Estimated Volume of Waste

The approximate volume of waste material in the landfill has been estimated at 2.4×10^6 cubic yards. Numerous sources, including well logs, aerial photographs, geophysical surveys and topographic maps were used to aid in determining the approximate location and volume of waste material buried in the landfill. Because the types of waste were unknown, no attempts were made during the volume approximation to distinguish between domestic and industrial wastes. Due to the lack of pertinent information no distinction could be made between hazardous and non-hazardous wastes. Since the available information suggests that the wastes disposed of in the landfill were not segregated, the total estimated volume is considered hazardous. This estimated volume also does not include the surface debris previously discussed.

The assumptions concerning the volume of waste, presented below, were crudely defined and the resulting estimation of volume is only useful in determining cost ranges for remedial alternatives. The exact volume and type of waste disposed of within the landfill is unknown.

The delineated sections shown in Figure 3-9 were defined using historical photographs taken by EPIC between 1955 and 1979 and magnetometer surveys performed in 1982 by Ecology and Environment, Inc. and in 1984 by NUS Corporation. The depth of each section was approximated based on available borehole logs and topographic maps. Information used to calculate the volume of each section is presented in Table 3-2.



AREAS USED TO CALCULATE FILL VOLUME
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

FIGURE 3-9

NUS CORPORATION
A Halliburton Company

LEE 001
000868

TABLE 3-2
AREA AND DEPTH VALUES
USED TO CALCULATE WASTE VOLUME
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Section	Estimated Surface Area (acres)	Estimated Waste Depth (feet)	Estimated Volume (cubic yards)
	Northern Tract		
A	3.2	40	206,000
B	6.2	25	250,000
	Central Tract		
C	2.7	5	22,000
D	1.2	5	9,700
E	13.0	25	524,000
F	0.62	20	20,000
G	1.8	20	58,000
H	1.9	20	61,000
	Southern Tract		
I	2.7	25	109,000
J	20.9	25	843,000
K	7.9	25	319,000

Notes: See Figure 3-9.

3.3.1 Northern Tract

The approximate volume of waste in the Northern Tract has been estimated at 2.56 x 10^5 cubic yards based on the assumptions presented below.

Section A — A large magnetic anomaly was delineated in the eastern portion of the Northern Tract. A well log from the installation of a Phase IV gas monitor well by SCS Engineers showed a refuse depth of approximately 40 feet.

Section B — Both the historical photographs and the magnetic surveys indicated possible disposal activity in this area. Based on the rapid slope of the land surface near the river as shown on the available topographic maps, the average depth of the fill material in this area was assumed equal to 25 feet.

3.3.2 Central Tract

The approximate volume of waste in the Central Tract has been estimated at 6.95 x 10^5 cubic yards based on the assumptions presented below:

Sections C,D — Most of the northern portion of the Central Tract between the levee and the access road was used as an auto junkyard. It is assumed that the activity in this area was limited to surface storage of junk. The surface scaring and staining liquids seen on several aerial photos was assumed to be due to the moving and storing of old automobiles. It is believed that excavation did not occur in this area. A minimal depth of 5 feet is assumed for these areas to allow for seepage of oils and grease into the soils.

Section E — The southern portion of the Central Tract between the levee and the access road was used for disposal of waste. Since there is evidence of continuous traffic across this section it is assumed that the excavated depth was relatively uniform. Gas monitor wells installed by SCS Engineers in 1979 indicated a refuse depth between 20 and 25 feet below the surface. 25 feet was the depth used to calculate the volume.

Sections F,G,H — Historical photographs indicate that excavation and filling activity occurred in several areas between the access road and the river. A monitor well installed in section F indicates a fill depth of 20 feet. It is assumed that the excavation and fill activity was limited to areas that did not extend beyond the river bank bluff. Therefore, a 20-foot fill depth was assumed for these areas.

3.3.3 Southern Tract

The approximate volume of wastes in the Southern Tract has been estimated at 1.27×10^6 cubic yards based on the assumptions presented below. Because of the size and topography of the two depressions in the Southern Tract, it is believed that wastes were not buried in either of these areas.

Section I — Historical photographs indicate continuous excavation and filling activity. The magnetometer survey showed high anomalous areas. An average depth of 25 feet was assumed based on physical features and topographic information.

Section J — From historical photographs this area was, apparently, where most of the mining operations occurred after

1950. Present topographic information and suspected slope of the pit during activity suggest an average fill depth of 25 feet within this section.

Section K — Historical photographic interpretation shows excavation and fill activity were limited to areas off the river bank. Topographic information and physical features indicate a possible fill depth of 25 feet.

3.4 Waste Containment

Containment of leachate generated by the wastes can not be expected based on the available information concerning the geologic conditions and operation of the landfill site. There are no known liners or leachate collection systems currently in operation at the site. The natural materials in the alluvial aquifer beneath the landfilled area were estimated to have a permeability of 8.90×10^{-3} cm/sec based upon in-situ hydraulic conductivity tests conducted on MW-04 (see Section 4.3.4.2 the discussion of permeabilities.) The soils above the aquifer are estimated to be an order of magnitude less permeable than the alluvial aquifer.

Observations recorded during the RI noted the apparent continued subsidence of the landfill as evidenced by relatively large depressions in the access road. These observations suggest that compaction may still be occurring at the site.

Since there are no available measurements on the permeability of the cover material at the landfill, the rate of percolation of rainwater and river water through the surface soils cannot be determined. Although the surface has not been graded to promote drainage, very little ponding was noted during the RI. Visual evidence suggests that the landfill cover does not appear to be capped with soils that would inhibit infiltration of surface waters.

Generally, the thicker the fill, the more concentrated the leachate will become. Quality of the leachate is a function of the composition, degree of compaction, moisture content, age of the disposal facility, depth and areal extent of the landfill, sorting, and the temperature, which will influence bacterial activity. Attenuation of leachate in the soil can take place as ion exchange, filtration, adsorption, complexing, precipitation and biodegradation. The quantity of leachate is affected by the composition of refuse, the rate of decomposition, chemical and hydrological quality of the soil, and the amount of water passing through the fill material. The quantity of contaminants will decrease as they are leached from the fill over a long period of time (e.g., 50 to 100 years).

As discussed previously, data pertaining to the actual depth of fill throughout the site are limited. Water level measurements taken from wells within the fill area indicate groundwater levels below the suspected fill areas. Under normal flow conditions in the Ohio River it is assumed that the groundwater level will be below the fill material, but under high flow conditions the groundwater table may intersect the fill material in some areas. Detailed measurements of groundwater response to Ohio River stage were made from December of 1984 through May of 1985 during the RI. The results of these measurements are discussed in more detail in Section 4.3.4.1. Fluctuations of up to seven feet were noted during this period when flood stages were below normal.

Besides the markedly varying topography, the appearance of the cover in the Southern Tract is similar to that of the rest of the landfill with the exception of a wet area on the southeastern portion of the tract.

3.5 Waste Composition

Limited data are available on the wastes that are contained in the Lees Lane Landfill. During the design of the RI, it was determined that the nature of the landfilling operation (described in Section 3.1) precluded waste characterization at the site. This is due to the wide range of disposal practices, including open dumping and filling of the previously excavated sand and gravel pits, and the apparent lack of waste segregation. In addition, sampling of the waste materials in the landfill through the use of soil borings is likely to present significant health risks due to the levels of methane present. However, a combination of historical information and available analytical data has been used to describe suspected waste components at the site.

3.5.1 Waste Types

The Lees Lane Landfill Site received domestic, commercial, and industrial wastes over a 27-year period, but there are limited data concerning the type and quantity of wastes on the site. The only available historical records identify that at least 212,400 tons of mixed industrial waste (some drummed) were disposed of at the Lees Lane Landfill by four industrial firms. In addition, municipal solid waste was also disposed of at the site, but the quantity and types are unknown.

The Eckhardt Report from 1979 indicates a partial list of those companies which disposed of their wastes in the landfill. Table 3-3 lists these companies and the types and amounts of wastes reported during the Congressional Investigation. This investigation sought to identify the waste components being disposed of at the site by subdividing process wastes into the following categories:

- Acid solutions with a pH less than 3
- Base solutions with a pH greater than 12
- Metals (bonded organically and inorganically)
- Radioactive residues greater than 50 picocuries/gram
- Organics
- Inorganics
- Miscellaneous

Of the four companies reporting the disposal of wastes at Lees Lane Landfill, only two of the categories of waste, base solutions and radioactive residues, were not identified as being disposed of in the landfill.

LEE 001 000874

TABLE 3-3

HAZARDOUS WASTES REPORTED TO BE DISPOSED OF IN LEES LANE LANDFILL

Company	Dates Used	Disposal Areas	Hundred Tons	Type of Waste
The B. F. Goodrich Company - Chemical Group	1948-1971 1972-1976	North Site South Site	1,514 175	Zinc, cadmium, copper, chromium (trivalent) lead, halogenated aliphatics, acrylates and latex emulsions, plastizers, resins, elastomers.
The Harshwaw Chemical Company - A Division of Gulf Oil Corp.	1950-1967	Lees Lane Landing Landfill	1	Arsenic, selenium, antimony, iron, manganese, magnesium, zinc, cadmium, copper, chromium (trivalent and hexavalent), lead, insecticides, amides, amines, imides, resins, salts, miscellaneous paints and pigments.
Rohm & Hass Company - Louisville Plant	1962-1970	West End-Lees Lane	343	Amides, amines, imides, plastizers, resins, salts, acid solutions (with pH less than 3).
Celanese Corporation - Celanese Polymer Special. Co.	1967-1974	Lees Lane Sanitary Landfill	91	Acid solutions (pH less than 3), arsenic, selenium, antimony, mercury, iron, manganese, magnesium, zinc, cadmium, copper, chromium (trivalent and hexavalent), lead, halogenated aliphatics, amides, amines, imides, resins, polar and non-polar solvents, oils and oil sludges, esters, and ethers, alcohols, ketones and aldehydes, salts, miscellaneous paints and pigments, asbestos, wastes with flash point below 100° F.

Source: Eckhardt, 1979.

By 1984, the EPA had identified over 100 potentially responsible parties. However, the types and quantities of wastes disposed of in the landfill by these parties has not been determined.

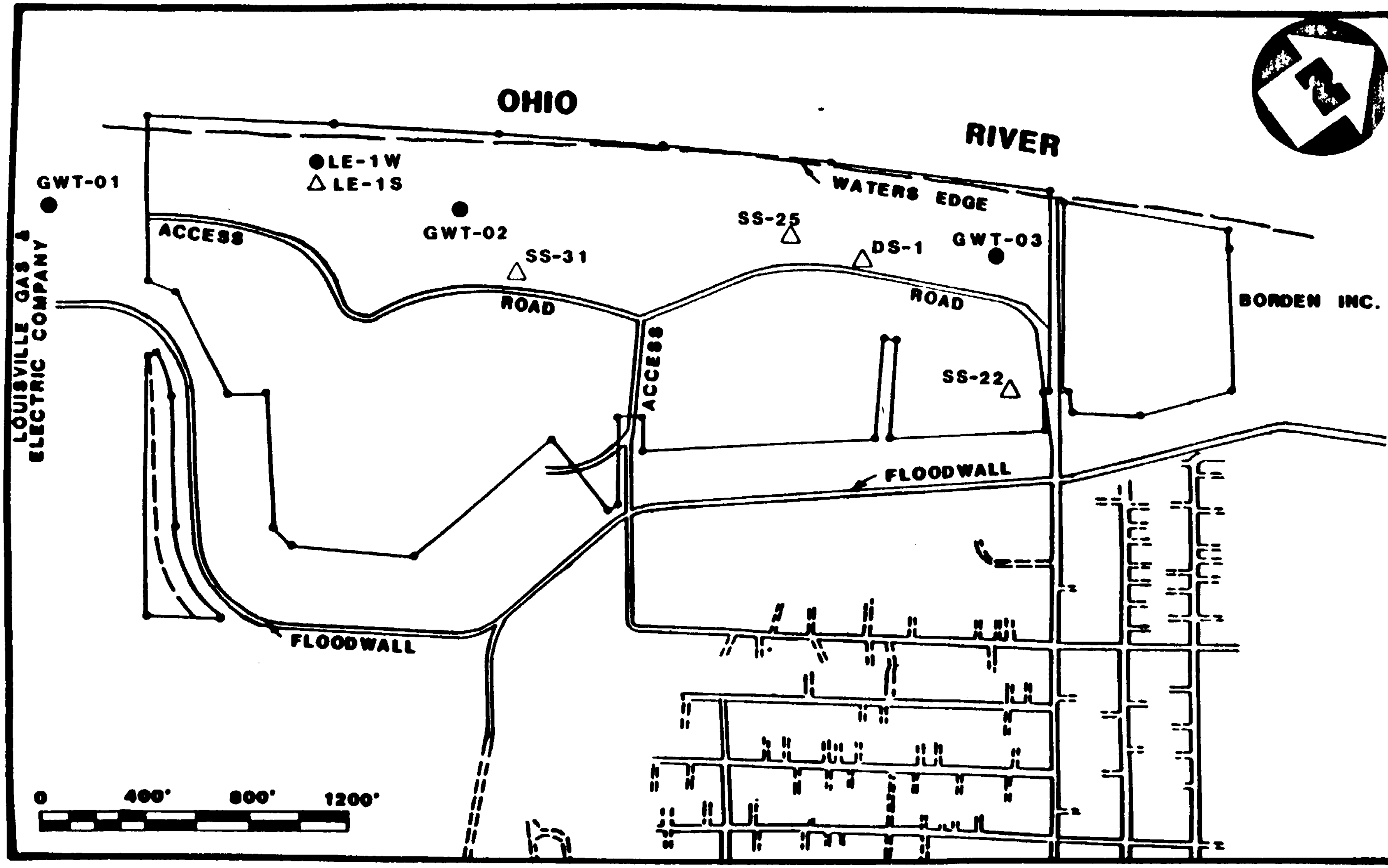
The wide variety of potential wastes (both domestic and industrial), that may have been disposed of at the landfill combined with the lack of segregation of wastes, suggests that any attempt to identify waste components in a specific area is virtually impossible. However, knowledge of general waste components is necessary for the FS to estimate the costs of disposal of excavated waste as well as to determine the compatibility of landfill leachates with potential materials to be used for liners, groundwater barriers, or other such structures where the leachate may contact the barrier materials.

3.5.2 Waste Forms

Wastes deposited at the landfill could include containerized and uncontainerized solids and liquids. The only analytical account of wastes at the site was provided by five samples from the 400 drums which were exposed along the Ohio River Bank. The drum samples contained 51 different organic compounds as well as high concentrations of copper, cadmium, nickel, lead, and chromium. Benzene, phenol, and their ethylated derivatives were also identified. The analytical results from the drum samples were reported by the Kentucky Natural Resources and Environmental Protection Cabinet (NREPC) in 1980. In September 1981 the contents of the drums were removed and shipped to a State-approved facility. With the approval of the Kentucky NREPC the empty drums were buried onsite.

In April 1981, monitoring wells installed by the Kentucky NREPC were sampled by the EPA. The results (see Section 4.4.1.2) indicated that very few organic contaminants were detected. Moderate concentrations of chromium, copper, nickel, and zinc were found in all wells. Mercury and selenium were detected in three wells.

Previous investigations at the site have included the collection of subsurface or leachate samples. (See Figure 3-10 for the locations of the samle collection areas.) In November 1982, a water and a sediment sample were collected from a leachate seep located on the western boundary of the landfill approximately 1,200 feet



WASTE SAMPLING LOCATIONS
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

LEGEND

● - WATER SAMPLE

△ - SOIL/WASTE SAMPLE

FIGURE 3-10

NUS CORPORATION
A Halliburton Company

LEE 001 000876

northeast of the confluence of Mill Creek and the Ohio River (LE-1W and LE-1S). In July 1983, two water samples (GWT-01 and GWT-03) and one soil sample (GWT-02) were collected from boreholes located on the river terrace. Also, in January 1985, a drilling residue sample (DS-1') was collected from the subsurface material deposited on the surface during the installation of MW-04.

The analyses of the above samples showed inorganic concentrations at levels common for landfill samples believed contaminated by wastes buried onsite (Tables 3-4 and 3-5). Most of the organics detected in the samples were estimated values or assumed present based on presumptive evidence (Tables 3-6 and 3-7). Elevated concentrations (ppm) of xylenes, toluenes and ethyl benzenes were detected in one water sample (GWT-03). Moderately elevated concentrations of PCBs and other organics were detected in the drilling residues and some of the other samples. The varied results from the analyses of the above sample tends to support the belief that waste material was randomly dumped at the site.

In November 1984 one surface waste sample was collected from the Central Tract (SS-22) and two soil samples were collected near drums located on the river bank terrace in the Central and Southern Tracts (SS-25 and SS-31). The analytical results of the samples collected around the drums (SS-25 and SS-31) show concentrations of both inorganics and organics similar to other surface samples collected at the site (see Sections 5.4.1 and 5.5.2). The surface waste sample (SS-22) analyses were atypical of other surface sample results. The sample contained no soil media and is readily discernable onsite. See Tables 3-8 and 3-9 for the list of results.

Several gaseous contaminants have been detected at the site. As described in Section 6.0, Air/Gas Migration Investigation, high levels of methane were found in observation wells installed around the landfill. Other gases, such as vinyl chloride and benzene, have also been found in samples collected from some of the wells.

3.5.3 Waste Characteristics

Many of the materials suspected to be buried at the Lees Lane Landfill are suspected hazardous substances. A few characteristics of substances known to be onsite are:

TABLE 3-4
SUMMARY OF INORGANIC ANALYTICAL RESULTS OF WATER SAM
POTENTIALLY CONTAMINATED BY BURIED WASTES
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Parameter in ug/l	Water at 38 Feet GWT-01 7/83	Water at 28 Feet GWT-03 7/83	Leachate Seep LE-1W 11/82
Inorganics			
Arsenic	58(A)	30(A)	80
Boron	2,800	2,700	NA
Barium	7,500	2,600	620
Beryllium	64	52	-
Cadmium	8.3(A)	120(A)	8
Cobalt	860	800	NA
Chromium	700	270	100
Copper	1,000	390	200
Nickel	1,200	1,100	140
Lead	1,300	970	200
Selenium	6.9(A)	-	-
Strontium	NA	NA	430
Titanium	NA	NA	550
Vanadium	770	540	120
Yttrium	NA	NA	48
Zinc	3,700	2,800	720
Mercury	2.7	2.9	-
Aluminum	590,000	210,000	60,000
Manganese	22,000	33,000	5,200
Calcium	NA	NA	110,000
Magnesium	NA	NA	40,000
Iron	620,000	580,000	110,000
Sodium	NA	NA	19,000
Cyanide	-	-	4

(A) Value is suspect.
- Not detected.

TABLE 3-5
SUMMARY OF INORGANIC ANALYTICAL RESULTS OF SOIL SAMPLES POTENTIALLY CONTAMINATED BY BURIED WASTES
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Parameter mg/kg	Drilling Residues DS-1' 1/85	Soil at 17 feet GWT-02 7/83	Leachate Seep LE-1S 11/82
Inorganics			
Silver	-	-	-
Arsenic	-	3.2(A)	-
Boron	NA	60	NA
Barium	86	400	61
Beryllium	0.7	0.25	-
Cadmium	-	2.0(A)	-
Cobalt	9.3	6.3	NA
Chromium	12	19	17
Copper	27	50	16
Nickel	11	21	24
Lead	35J	800	29
Antimony	-	1.2(A)	-
Tin	-	13	-
Strontium	NA	NA	18
Tellurium	NA	NA	-
Titanium	NA	NA	310
Vanadium	12	-	34
Yttrium	NA	NA	10
Zinc	68	490	120
Mercury	0.33	2.4	0.10
Aluminum	4,400	3,600	7,300
Manganese	620J	440	440
Calcium	15,000	NA	6,200
Magnesium	3,100	NA	3,400
Iron	16,000	10,000	27,000
Sodium	R	NA	-
Cyanide	-	-	0.26

- Not detected.
(A) Data is suspect.
J Estimated value.
NA Not analyzed.
R Quality control information indicates data is invalid.

TABLE 3-6
SUMMARY OF ORGANIC ANALYTICAL RESULTS OF WATER SAMPLES POTENTIALLY CONTAMINATED BY BURIED WASTES
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Parameter in ug/l	Water at 38 Feet GWT-01 7/83	Water at 28 Feet GWT-03 7/83	Leachate Seep LE-1W 11/82
Extractable Organics			
Naphthalene	-	520J	-
Bis (2-ethylhexyl) Phthalate	-	860J	-
Hexahydroazepinone	30JN	-	-
C_3 Alkylbenzene (6 isomers)	-	28,000JN	-
Purgeable Organics			
Toluene	-	34,000	-
Ethyl Benzene	-	23,000	-
M-Xylene	-	40,000JN	-
O & P-Xylene (mixed)	-	73,000	-
Acetone	250	-	-
Unidentified Compounds	-	1-1,000J	-
Pesticides/PCBs			
PCB-1260	-	15	-

- Not detected.
J Estimated value.
N Presumptive evidence of presence of material.

TABLE 3-7
SUMMARY OF ORGANIC ANALYTICAL RESULTS OF SOIL SAMPLES
POTENTIALLY CONTAMINATED BY BURIED WASTES
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Parameter in mg/kg	Drilling Residue DS-I' 1/85	Soil at 17 Feet GWT-02 7/83	Leachate Seep LE-IS 11/82
Extractable Organics			
Phenanthrene	500J	-	430
Anthracene	100J	-	200J
Fluoranthene	700J	-	-
Pyrene	600J	-	500J
Bis(2-Ethylhexyl)Phthalate	700J	-	-
Benzo(A)Anthracene	300J	-	290
Chrysene	300J	-	360
Benzo(B)Fluoranthene	300J	-	200J
Benzo(K)Fluoranthene	NA	-	200J
Benzo-A-Pyrene	300J	-	230
Indeno(1,2,3-CD)Pyrene	200J	-	-
Benzo(GHI)Perylene	300J	-	-
Methyldecahydronaphthalene (2 Isomers)	1,000JN	-	-
Hexadecanoic Acid	-	50,000JN	-
Benzoic Acid, Methyl Ester	-	-	1,400JN
Ethyldecanol	-	-	1,400JN
Benzofluorene	-	-	1,400JN
Benzofluoranthene (2 Isomers not 'B' or 'K')	-	-	1,400JN
Sulfur	-	70,000JN	-
Purgeable Organics			
1,1-Dichloroethene	-	9J	-
1,1-Dichloroethane	-	300	-
1,2-Dichloroethane	-	1,900	-
Benzene	-	220	-
1,1,2-Trichloroethane	-	170	-
Toluene	12	170	-
Chlorobenzene	1J	380	-
Ethyl Benzene	4J	190	-
M-Xylene	-	300JN	-
O & P-Xylene (Mixed)	-	140	-
Styrene	1J	-	-
Total Xylenes	4J	-	-
Acetone	-	360	-
Methyl Ethyl Ketone	-	350	-

TABLE 3-7
SUMMARY OF ORGANIC ANALYTICAL RESULTS OF SOIL SAMPLES POTENTIALLY CONTAMINATED BY BURIED WASTES
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY
PAGE 2

Parameter in mg/kg	Drilling Residue DS-1' 1/85	Soil at 17 Feet GWT-02 7/83	Leachate Seep LE-1S 11/82
Purgeable Organics (cont'd)			
Methyl Isobutyl Ketone	-	520	-
Dichlorocyclobutane	-	200JN	-
Dichlorobutene (4 Isomers)	-	2,500JN	-
Pesticides/PCBS			
PCB-1254	48N	-	-

J Estimated value.
\- Not detected.
NA Not analyzed.
N Presumptive evidence of presence of material.

TABLE 3-8
SUMMARY OF INORGANIC ANALYTICAL RESULTS OF SURFACE WASTE SAMPLES AND SOILS SURROUNDING EXPOSED DRUMS
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Parameter in mg/kg	Surface Waste Sample SS-22 11/84	Soils Near Exposed Drums SS-23 11/84	SS-31 11/84
Inorganics			
Silver	-	-	4.4
Arsenic	190	19	11
Barium	49	130	46
Beryllium	5.2	0.89	-
Cadmium	-	9J	-
Cobalt	-	22	7.2
Chromium	5,000J	30J	10J
Copper	3,000J	40J	20J
Nickel	20J	30J	10J
Lead	20,000J	70J	50J
Antimony	84	-	-
Vanadium	6J	20J	10J
Zinc	7,400	170	60
Mercury	11	0.46	0.21
Aluminum	110,000	9,200	3,600
Manganese	510	1,300	310
Calcium	1,300	7,800	1,800
Magnesium	4,000J	5,000J	2,000J
Iron	14,000	28,000	21,000
Sodium	20,000J	10,000J	-
Cyanide	7J	0.7J	-
Potassium	1,400	1,600	800

- Not detected.
J Estimated value.

TABLE 3-9
SUMMARY OF ORGANIC ANALYTICAL RESULTS OF SURFACE WASTE SAMPLES AND SOILS SURROUNDING EXPOSED DRUMS
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

	Waste Material	Soils Near Exposed Drums	
	SS-22	SS-25	SS-31
Parameter in mg/kg	11/84	11/84	11/84
Extractable Organic			
Unidentified Compounds	-	-	4-300,000J
Purgeable Organics			
1,1,1-Trichloroethane	-	-	6J
Toluene	10	-	17
Acetone	32	-	-
Methylpropanal	-	7JN	-
Propanoic Acid, Methylmethyl Ester	-	2	-
Butanoic Acid, Methyl Ester	-	1JN	-
Methylbutanone	-	3JN	-
Dichlorocyclobutane	13JN	-	-
Dichlorobutene	20JN	-	-
Unidentified Compounds	2-6J	1-20J	-
Pesticides/PCBs			
PCB-1254	1,000JN	-	-
PCB-1260	-	40J	-

- Not detected.

J Estimated value.

N Presumptive evidence of presence of material.

- Ignitability
  - methane

- Reactivity/Incompatibility
  - vinyl chloride
  - dichloroethylene
  - methane

- Persistency
  - chromium

- Toxicity (examples of compounds onsite with a Sax Level 3 ranking)
  - dichlorodifluoromethane
  - phenol
  - chromium
  - arsenic

- Carcinogenicity
  - benzene
  - vinyl chloride

Since debris was randomly dumped into the landfill the effect and characteristics of subsequent mixing products can not be determined.

3.6 Hazardous Substance Summary

The landfill was operational for a period of years between 1940 and 1975. At closure, the site was not graded to promote drainage and, therefore, the surface is irregular. A large depression is located in the Southern Tract. The cover material is composed of local soils and appears to be moderately permeable based on the general absence of ponded water observed during the RI.

There is no evidence to suggest that liners, leachate collection systems, or surface water diversions were implemented at the site. Also, undulations in the access road indicate that settlement of the waste may still be occurring.

The estimated depth of the filled areas ranges between 20 and 40 feet with a total estimated fill volume of 2.4×10^6 cubic yards. Municiple, industrial and commercial wastes are known to have been disposed of in the landfill but no information is available as to the actual composition, type and location of specific waste. Available records (Table 3-3) indicate that both hazardous and non-hazardous wastes may have been dumped at the site and, due to landfilling practices at the time of operation, were comingled. Previous sampling investigations support the continued degradation of organic matter and the production of gases associated with landfilled material.

4.0 HYDROGEOLOGIC INVESTIGATION

The geologic and hydrogeologic investigation performed during the Remedial Investigation (RI) at the Lees Lane Landfill Site was designed to determine subsurface geologic conditions, groundwater flow paths and mechanisms for contaminant transport. To accomplish these tasks a literature review was performed, a drilling and monitor well installation program was carried out and a groundwater sampling program was conducted.

4.1 Geology

The geologic materials in the vicinity of the Lees Lane Landfill Site are the result of the development of the Ohio River Valley. The Ohio River Valley in Kentucky is a broad, U-shaped rock-bottomed trough partly filled with clay, silt, sand, gravel, and some deep lying boulders. The alluvial surface is relatively smooth and even, and slopes gradually toward the river, except where it is broken by sloughs and remnants of alluvial terraces (Gallaher, 1966).

4.1.1 Regional Geology

The consolidated materials underlying the Louisville, Kentucky area are composed of limestone and shale of Silurian, Devonian, and Mississippian age. The bedrock formations in the area are of fairly uniform thickness and dip toward the southwest at about 40 feet per mile. West and southwest of Louisville, the bedrock surface consists of the New Albany shale of Devonian age (Bell et al, 1963).

During Pleistocene time the Ohio River cut its valley into the limestone and shale to a maximum depth of nearly 130 feet below the present flood plain. The valley was later filled to its present level with glacial-outwash sand and gravel, and river deposits of Pleistocene and Recent age (Bell et al, 1963).

The deposits of Pleistocene age include the glacial-outwash sand and gravel ranging from 0 to 100 feet in thickness, overlain by a blanket of silt and clay as much as 40 feet thick. Very thin deposits of Recent clay and silt cover portions of the floodplain. The sand and gravel deposit is thinnest in the northwestern part of Louisville; the silt and clay is thickest near the Ohio River (Bell et al, 1963).

Table 4-1 describes the lithology and water-bearing characteristics of the geologic units in the area.

4.1.2 Site Geology

A subsurface investigation was conducted at the site during November and December 1984. The investigation was used to determine subsurface lithology through a drilling and sampling program and to provide groundwater sampling points through a well installation program. The investigation consisted of five boreholes at four different locations (See Figure 4-1). Appendix B contains a discussion of the test boring and well installation programs.

The geology encountered during the subsurface investigation at the Lees Lane Landfill Site consisted of Ohio River alluvium composed of a recent silt and clay layer up to 20 feet thick overlying glacial outwash, sand and gravel with intermittent clay lenses. The alluvium and outwash was found to range from 86 to 114 feet in thickness. The New Albany shale was encountered beneath the alluvium. The shale was cored for 5 feet at three different locations. The New Albany Shale is of Devonian age and is reported to be 100 feet thick (EPA, 1982).

In 1945 the U.S. Geological Survey drilled and sampled a well in the Ohio River adjacent to the site (USGS, 1945). The depth of the river was reported to be 15 feet. The lithology encountered consisted of sand and gravel above shale bedrock. The sediments below the riverbed were reported to be 35.5 feet thick.

The alluvium exhibited a downward coarsening trend which is consistent with published reports for the area. Continuous clay and silt layers were found in the upper 10 to 20 feet and were thicker toward the Ohio River. Intermittent clay and silt was found throughout the lithology but no continuous layers were found below 20 feet that would give rise to more than one water-bearing zone.

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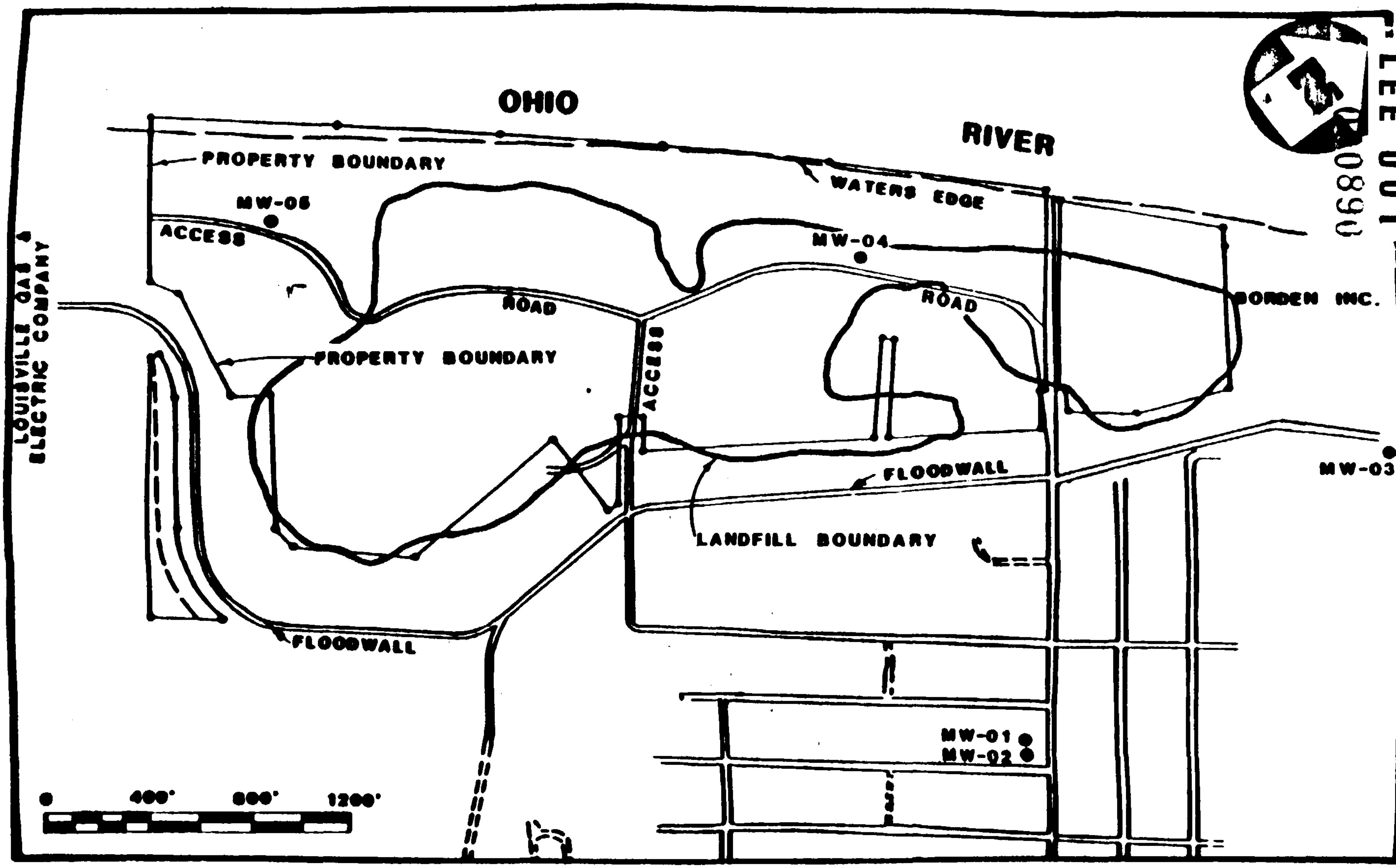
TABLE 4-1
STRATIGRAPHY AND WATER-BEARING CHARACTERISTICS OF GEOLOGIC UNITS IN VICINITY OF LEES LANE LANDFILL

SYSTEM	SERIES	GEOLOGIC UNIT	LITHOLOGY	WATER-BEARING CHARACTERISTICS
Quaternary	Pleistocene and Recent	Ohio River Alluvial Terraces	Soil, clay, cobbles, silt, fine sand; mostly alluvium; some glacial till, lacustrine, and eolian deposits. 5-130 feet thick.	Yields of 200-500 gpm common; Furnishes domestic and industrial supplies. Water generally is hard.
Devonian	Upper	New Albany Shale	Black, fissile, 100 feet thick.	Yields moderate to poor; water in fractures to 40 feet. May contain high concentrations of iron, salts, and sulfate.
	Middle	Sellersburg Limestone Jeffersonville Limestone	Limestone of variable character; 14 feet thick. Coarse-grained gray limestone, 20 feet thick These two formations cap highland areas.	Good domestic supplies available. Springs also utilized for domestic purposes.
Silurian	Upper	Undifferentiated; may include Louisville Limestone	Thick-bedded, dolomite, gray limestone, 40-100 feet thick.	Principal regional aquifer, may be cavernous along joints and bedding planes. Yields good supplies of water; a few springs occur just above contact with underlying shale unit.

Source: W. N. Palmquist Jr. and F. R. Hall, 1960, R. C. Kepferle, 1974, and L. M. MacCary, 1956.



BORING LOCATIONS
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

FIGURE 4-1

NUS CORPORATION
A Halliburton Company

LEE 001 0890

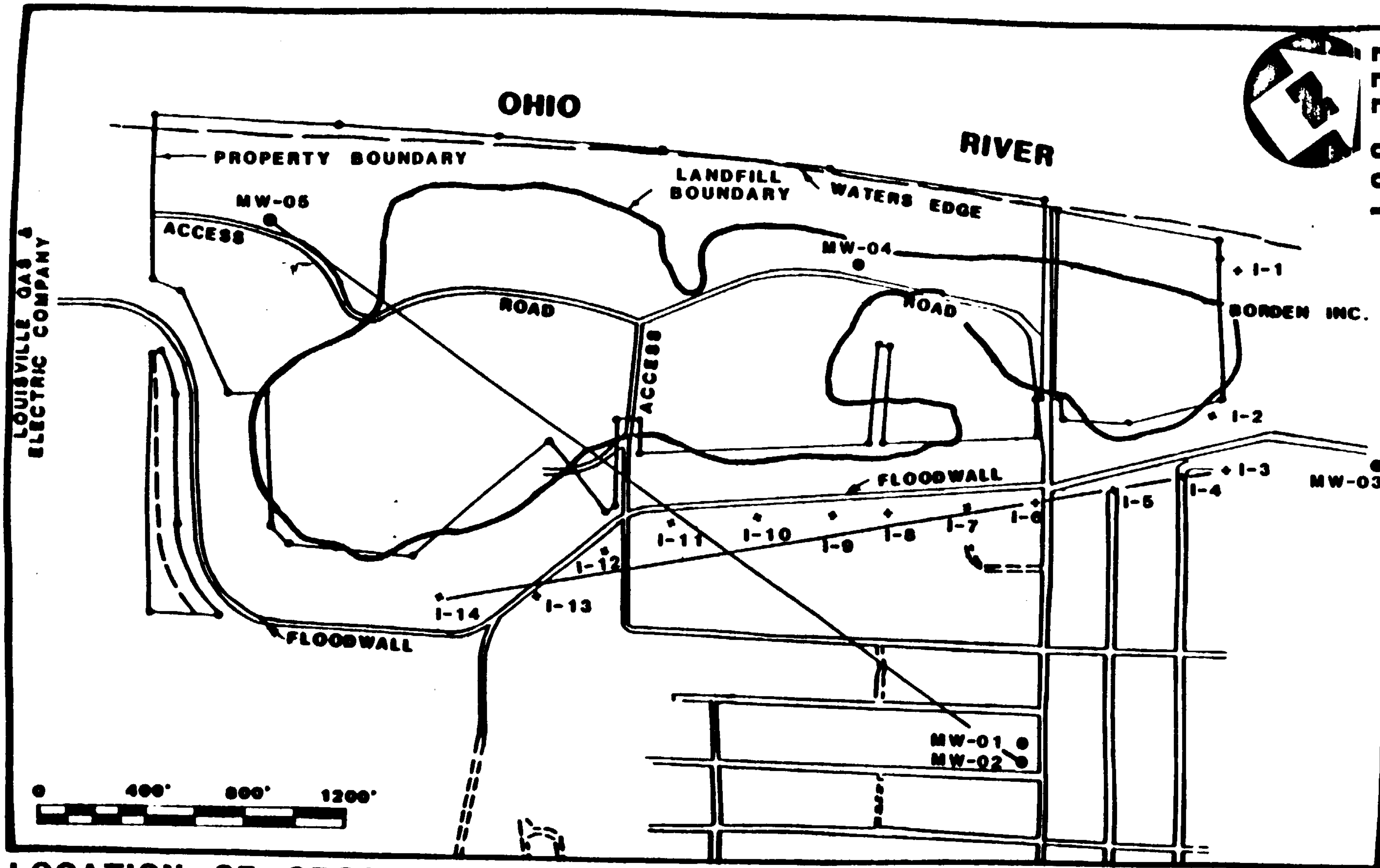
The New Albany shale underlying the alluvium was black, fissile and contained oil. Oil was visible when the cores were split and oil could also be seen in the drilling mud pan. The strike of the shale was found to be approximately N 25° E with the bedrock essentially flat. The dip of the shale was approximately 8.3 feet per mile in the direction of the Ohio River.

Cross-sections have been drawn to illustrate the geology on and around the site. Figure 4-2 is a location map for the cross-sections. The cross-section I-14 to I-3 shown on Figure 4-3 runs parallel to the flood levee and was developed using well logs from gas monitor wells installed by SCS Engineers in 1978. The SCS well logs are included in Appendix C. An additional cross-section MW-02 to MW-05, running from the upgradient well to the Ohio River through MW-05 was developed using well logs from the present study and is shown on Figure 4-4. This cross-section was developed to illustrate the lithologic units as well as to show the relationship between Ohio River water levels and groundwater levels during high flow periods. This relationship will be discussed in greater detail in Section 4.3.4. Figure 4-5 is a fence diagram that was developed using well logs from the present study and shows the lithology that was encountered.

4.2 Soils

The natural soils in the area consist of the Wheeling-Weinbach-Huntington Association located in the Ohio Valley. The association consists of very broad, nearly level ridges that have narrow side slopes running down to the bottoms along small branches. These branches are mostly parallel to the Ohio River and form a dominant drainage pattern. This association consists of long narrow strips that are parallel to the drainage system and ranges from half a mile wide along the northern edge of the County to more than 4 miles wide on the western side. The total acreage is about 14 percent of the County (Zimmerman, 1966).

Wheeling, Weinbach and Huntington soils each cover about 25 percent of this Association. Newark soils cover 10 percent, and the other minor soils about 15 percent. The minor soils present at the site consist of the Sciotoville soils and Breaks and Alluvial land (Zimmerman, 1966).



LOCATION OF CROSS-SECTIONS

LEES LANE LANDFILL SITE

JEFFERSON COUNTY, KENTUCKY

LEGEND

● - GROUNDWATER MONITOR WELLS

+ - GAS MONITOR WELLS

FIGURE 4-2

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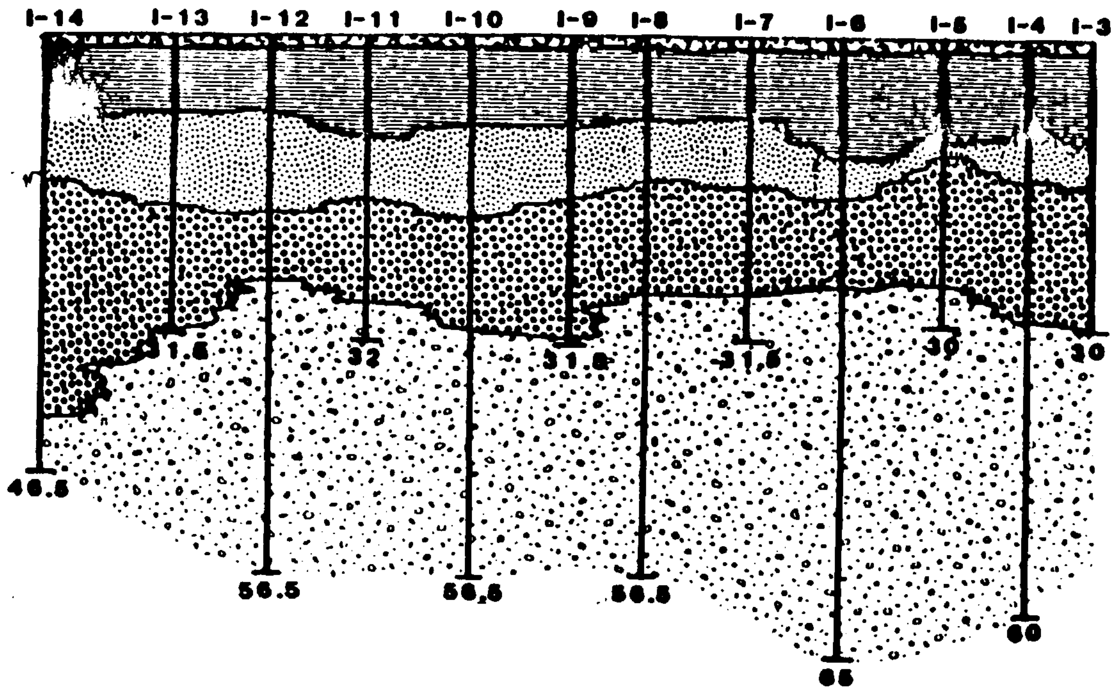
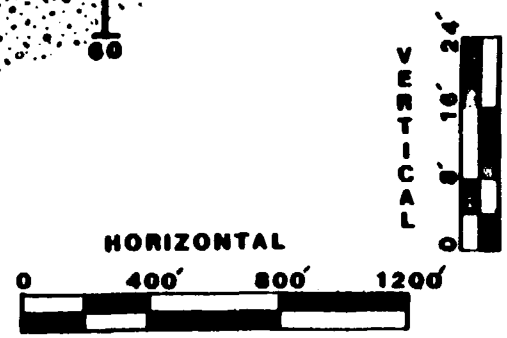


LEGEND

- TOP SOIL
- CLAYEY SILT
- FINE TO MED. SILTY SAND
- FINE TO MED. SAND
- MED. TO COARSE SAND W/ GRAVEL



CROSS–SECTION I-14 - I-3
LEES LANE LANDFILL SITE
JEFFERSON COUNTY , KENTUCKY

FIGURE 4-3

NUS CORPORATION
A Halliburton Company

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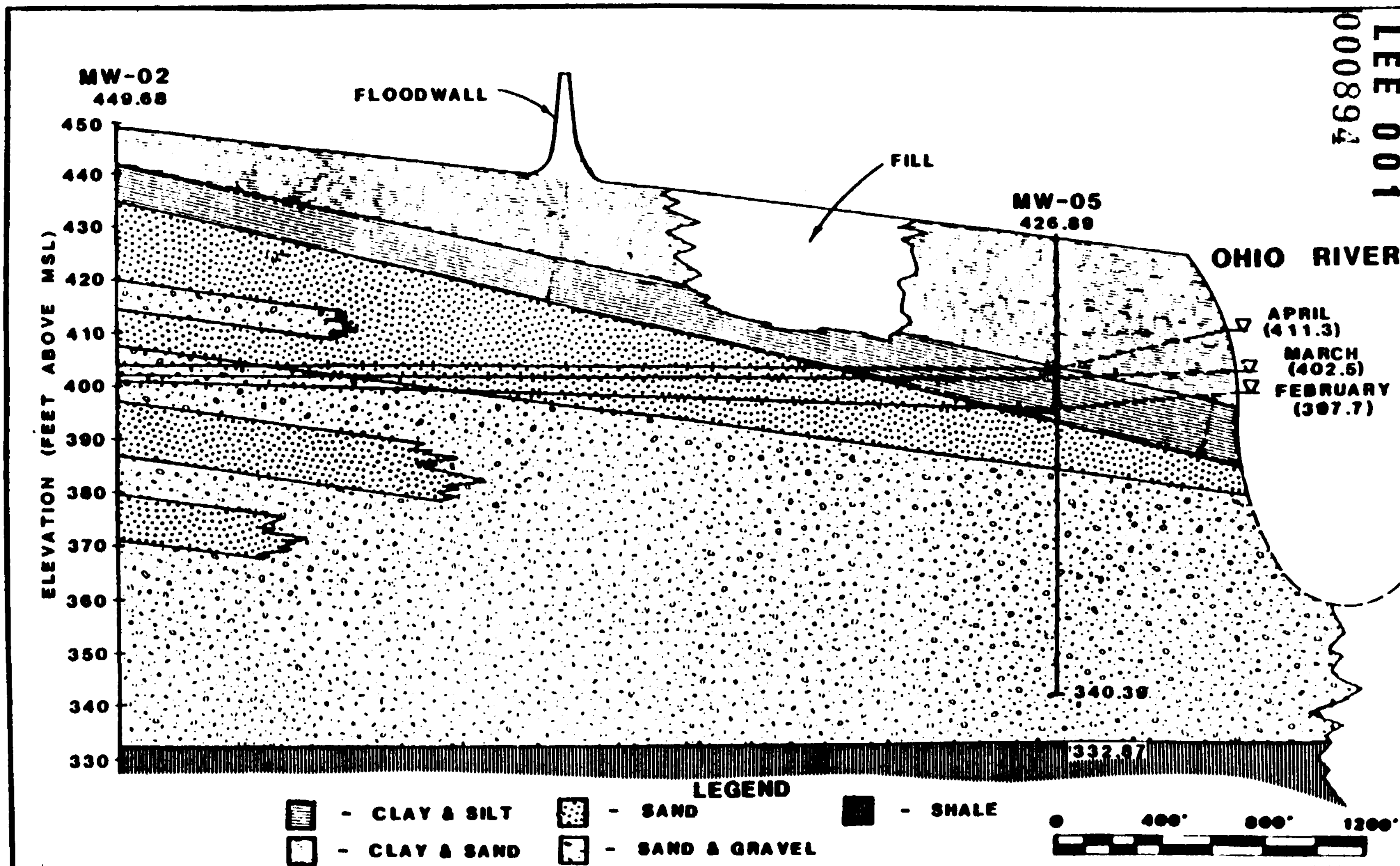

CROSS-SECTION MW-02 - MW-05

LEES LANE LANDFILL SITE

JEFFERSON COUNTY, KENTUCKY

FIGURE 4-4

NUS CORPORATION
A Halliburton Company

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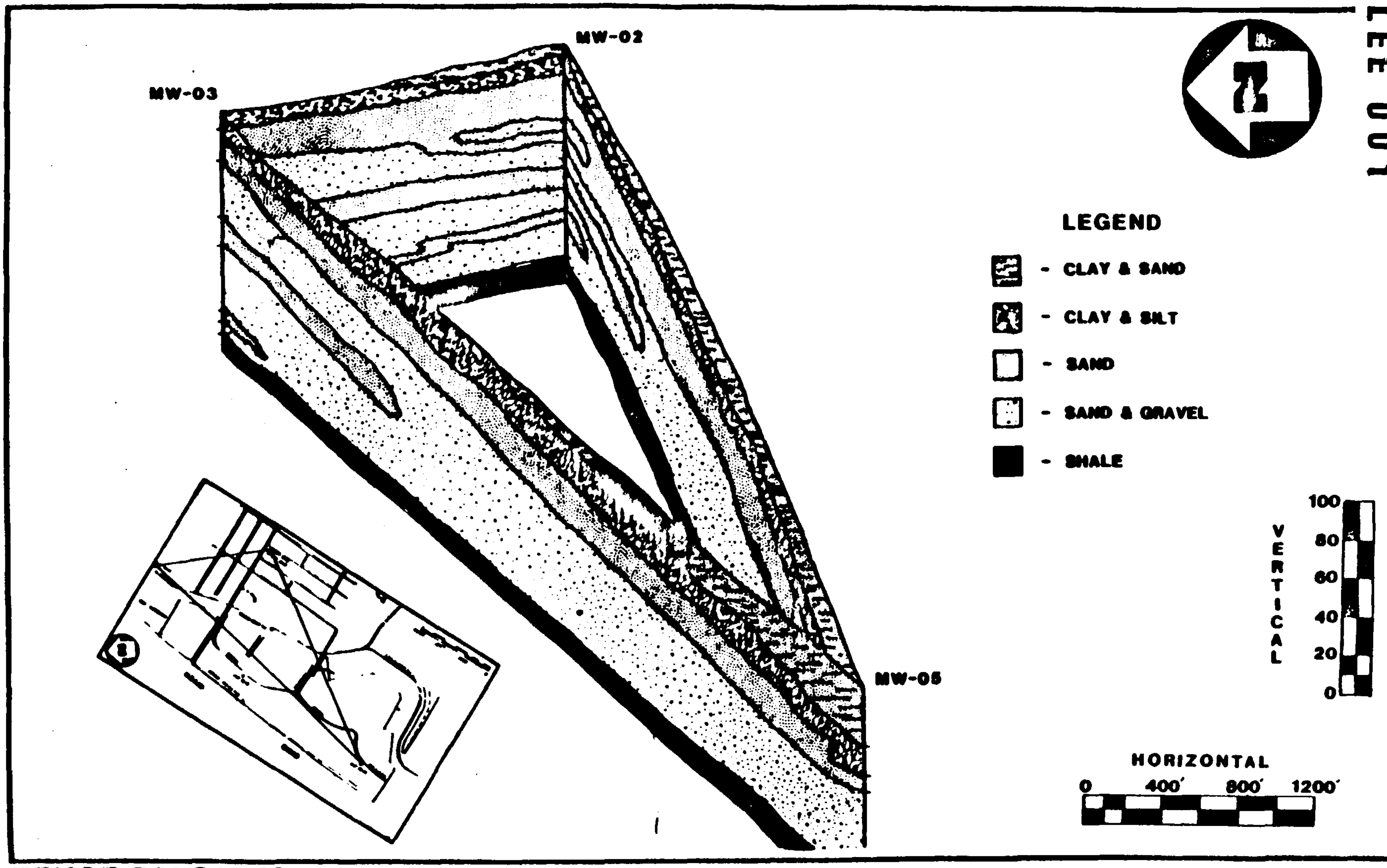


FENCE DIAGRAM
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

FIGURE 4-5

NUS CORPORATION
A Halliburton Company

Excavations and landfill operations at the site disrupted and replaced natural soil associations. Reportedly, wastes deposited at the site were ultimately covered with soil material derived from local sources.

4.2.1 Wheeling Series

This series consists of deep, silty, alluvial soils that are well drained. The soils are widely scattered on terraces in the Ohio Valley and cover a moderately large acreage. They formed in mixed sediments that washed from the upper part of the Ohio River basin. Wheeling soils are medium acid or strongly acid (Zimmerman, 1966).

4.2.2 Weinbach Series

The Weinbach Series consists of somewhat poorly drained alluvial soils that are widely scattered on terraces in the Ohio Valley. The areal extent is moderate. These soils formed in mixed sediment that washed from soils in the upper part of the Ohio River basin. They have a compact, brittle fragipan which occurs at a depth of 15 to 24 inches. The fragipan limits the depth of the root zone and restricts the movement of water. Weinbach soils are medium acid or strongly acid (Zimmerman, 1966).

4.2.3 Huntington Series

The Huntington Series consists of deep, well-drained soils that are on first bottoms along rivers and small creeks. The acreage is moderately large. Those soils along the Ohio River formed in mixed sediment that washed from the upper part of the Ohio River basin. Those soils along the creeks formed in sediment that washed mostly from soils of limestone origin. The soils are generally neutral or slightly acid. They have a high moisture-supplying capacity, a deep root zone, and other qualities that promote plant growth (Zimmerman, 1966).

4.2.4 Sciotoville Series

The Sciotoville Series consists of moderately well drained, alluvial soils that are widely scattered on terraces in the Ohio Valley. The acreage is moderate. These soils formed in mixed sediment that washed from the upper part of the Ohio River basin. They have a brittle, compact fragipan at a depth of about 25 inches which limits the depth of the root zone and restricts the movement of water. Sciotoville soils are generally strongly acid (Zimmerman, 1966).

4.2.5 Breaks and Alluvial Land

This is a miscellaneous land type that consists of areas of unconsolidated alluvium along the Ohio River that washed from the upper part of the Ohio River drainage basin. Most areas are strongly sloping or steep, a few are nearly level and some include an escarpment. In places, the deposits of alluvium are recent and are subject to yearly change, but in other places they have remained long enough to be distinguishable as weakly developed terrace soils. The soil material is mostly medium textured (Zimmerman, 1966).

4.3 Hydrogeology

The hydrogeology of the Louisville area consists of an alluvial aquifer and a series of limestone aquifers. The alluvial aquifer is characterized by sand and gravel deposits and is the principal water-bearing zone in the area. The alluvial aquifer is capable of yielding large quantities of water and most wells in the area utilize this aquifer. Beneath the alluvial aquifer is a shale aquitard (New Albany shale) reported to be 100 feet thick. The shale restricts the downward movement of water from the alluvial aquifer to lower water-bearing limestone units. The shale is capable of yielding poor to moderate amounts of water which can be of poor quality. Beneath the shale are a series of limestones which are capable of yielding good domestic water supplies. Both the alluvial and limestone aquifers are designated as Class II aquifers, current and potential sources of drinking water and waters having other beneficial uses (EPA, 1984).

4.3.1 Alluvial Aquifer

The dominant feature of the alluvial aquifer system in the Louisville area is the Ohio River and its flood plain underlain by about 100 feet of permeable sand and gravel deposits. The glacial deposit of sand and gravel in the flood plain has a vast water-storage capacity and a high transmissibility and makes up the alluvial aquifer which is the principal aquifer in the Louisville area. The deposits can be divided into two somewhat heterogeneous but distinctly different types. The lower part, deposited by a fast-moving stream, is primarily composed of boulders, cobbles, gravel, and coarse sand. This coarse material forms a rather persistent layer atop the bedrock across the width of the valley. Some clay, silt and fine-grained sand are also present, either mixed with the coarse material or in definite lenses. The upper part of the valley deposits is composed mostly of finer-grained material (clay, silt and sand) deposited during the recession of the last glacial period. Lenses of gravel and coarse sand are common, however, and represent periods of fast-moving water (Gallaher, 1966).

Porosities of the alluvial deposits in the Ohio River Valley are generally high. The sorting action of the streams has created deposits of relatively uniform grain size. A study of 66 samples of alluvium taken along the Ohio Valley in Kentucky show an average porosity of 43.2 percent. The maxiumum porosity is 53.5 percent; the minimum, 27.7 percent. Most samples showing low porosity were collected from areas where Ohio River alluvium had been mixed with tributary alluvium. In those areas, owing to mixing, a greater variety of grain sizes exists. Physical characteristics of the Ohio River alluvium, where mixing has not taken place are probably such that the overall porosities are higher than those shown by the tests (Gallaher, 1966).

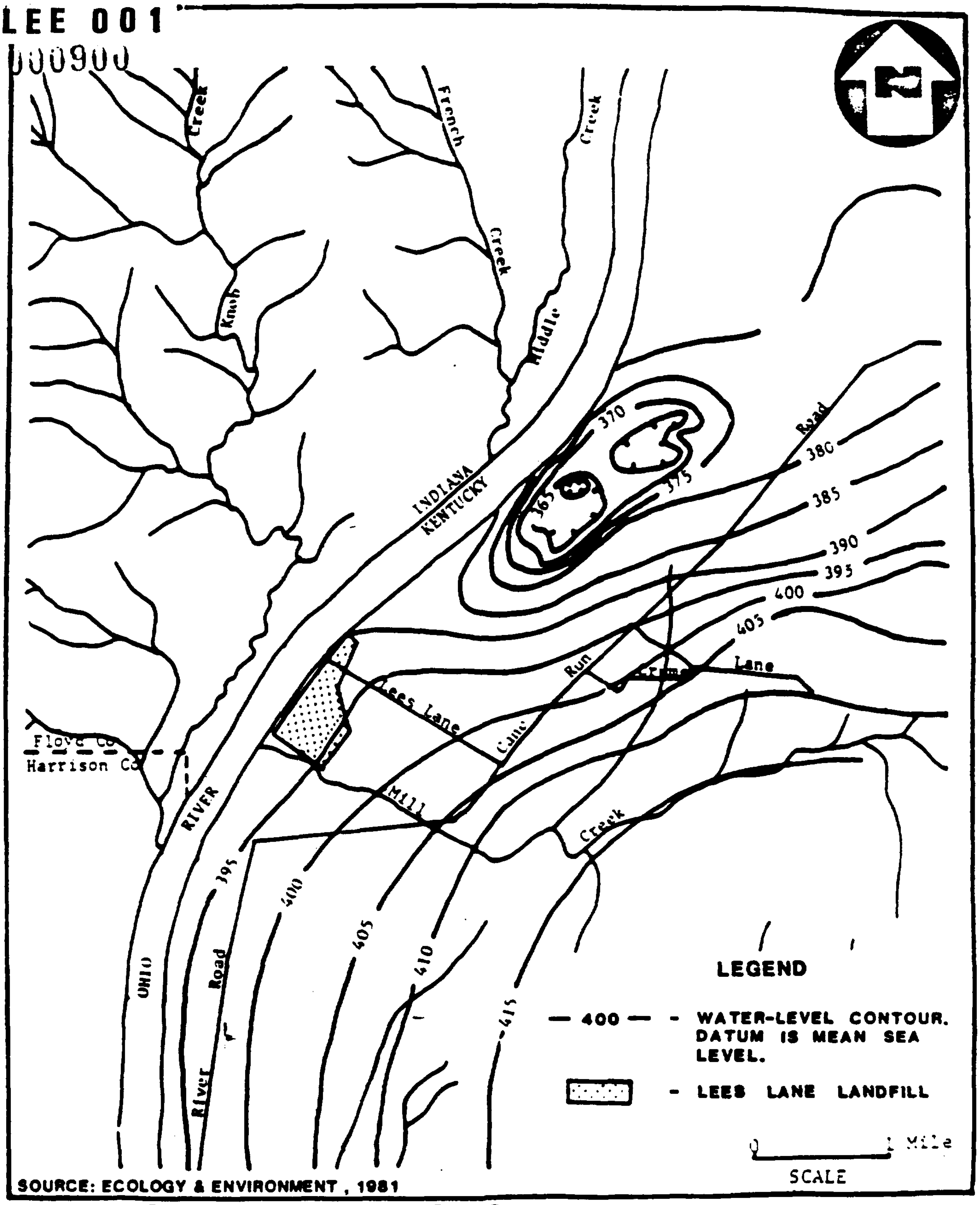
Permeability and transmissibility tests of the alluvium along the Ohio Valley in Kentucky have been conducted. Tests run in southwestern Louisville at West Point produced a maximum value of 1,400 gallons per day per square foot (gpd/ft^2) and a minimum of 150 gpd/ft^2 for permeability and a maximum of 45,000 gallons per day per foot (gpd/ft) and a minimum of 20,000 gpd/ft for transmissibility (Price, 1964).

The glacial-outwash sand and gravel is recharged naturally by precipitation that penetrates the flood plain, by infiltration from the river and by inflow from the bedrock forming the sides and bottom of the containing valley. From areas of recharge, the groundwater moves slowly toward points of lower water elevations and is discharged through wells in the area or to the river. The alluvial aquifer yields water to wells throughout the Louisville area except in the northwestern part of the City. In the alluvial aquifer, many of the wells discharge 100 to 500 gallons per minute (gpm), and a few wells discharge more than 1000 gpm. A "collector" well discharges as much as 2700 gpm (Bell et al, 1963).

Regional groundwater flow in the alluvial aquifer is toward the Ohio River. Historically, industrial pumping centers to the northeast of the site have created a cone of influence affecting groundwater flow. Figure 4-6 is a groundwater contour map of the alluvial aquifer in December 1962 showing the influence of the industrial pumping centers. Figure 4-7 is a groundwater contour map showing the direction of groundwater flow in October 1981. The influence of the industrial pumping centers has been reduced in the 1981 groundwater contour map. This would indicate a reduction in groundwater pumpage that was probably caused by the availability of a public water supply and some plant closings. The Louisville Gas and Electric Cane Run Plant located adjacent to the site now uses public water for drinking and processing and maintains wells only for fire protection. Stauffer Chemical, located adjacent to Borden Chemical, has recently closed its plant site.

4.3.2 Limestone Aquifers

Beneath the alluvium are a series of water-bearing shales and limestones. The Jeffersonville limestone is found in the central part of Louisville and is reported to yield more than 500 gallons per day (gpd) to drilled wells in broad, flat valleys or along streams on the upland (Palmquist, 1960). In the southern part of Louisville the New Albany shale underlies the alluvium and is reported to yield 100 to 500 gpd to shallow drilled wells in broad, flat areas, but almost no water to drilled wells on hillsides (Palmquist, 1960). Beneath the Jeffersonville limestone and the New Albany shale is the Louisville limestone. The Louisville limestone is reported to yield more than 500 gpd to wells drilled in valley bottoms or along streams in broad uplands and as much as 72,000 gpd in some places (Palmquist, 1960). The Waldron shale underlies the Louisville limestone and is not reported to have water bearing capabilities. A series of undifferentiated Silurian and Ordovician limestones are found beneath the Waldron shale and are reported to be water bearing.



1962 GROUNDWATER CONTOURS
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

FIGURE 4-6

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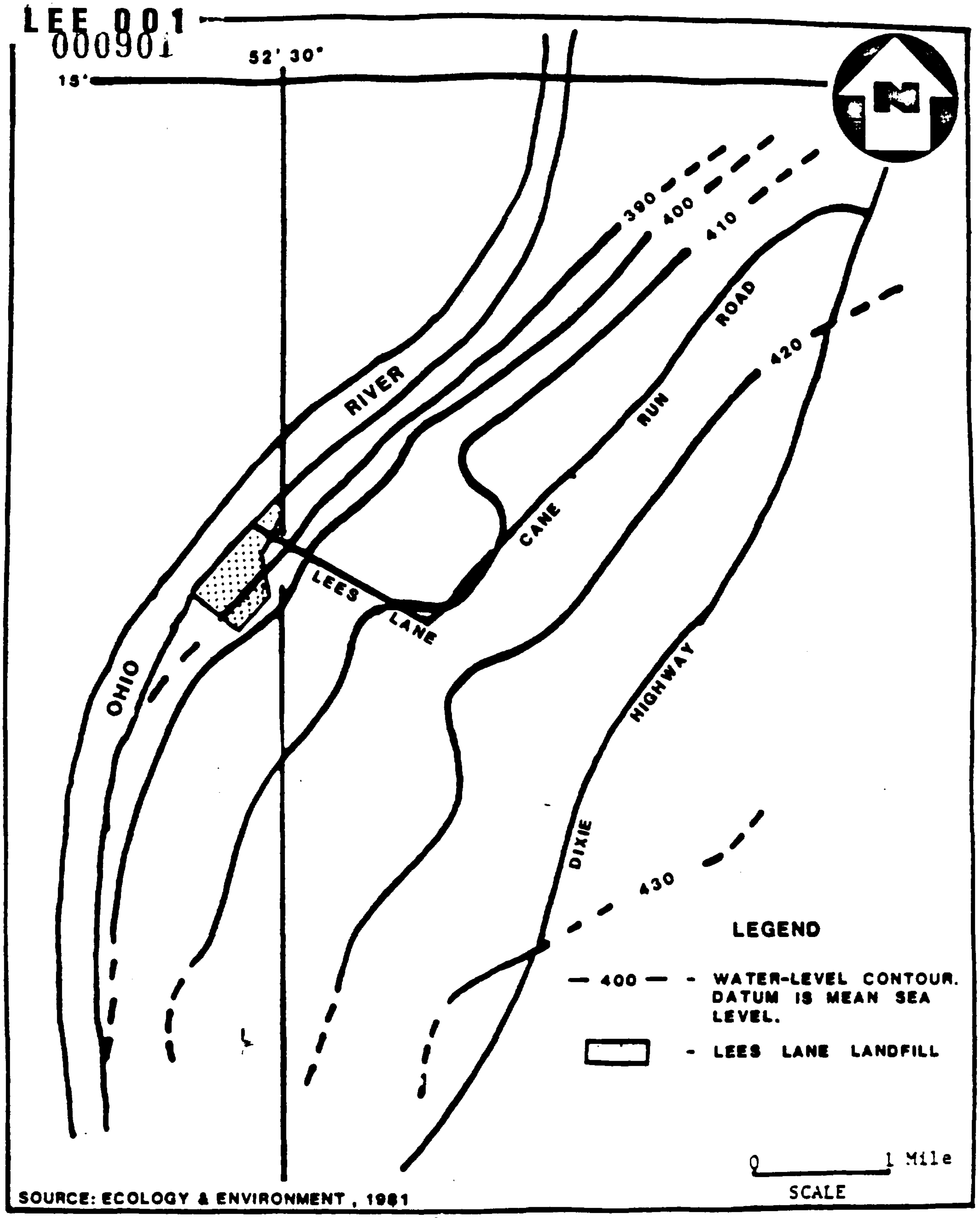

1981 GROUNDWATER CONTOURS
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

FIGURE 4-7

NUS CORPORATION
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4.3.3 Well Installation Programs

Well installation programs have been conducted on the site by the Kentucky Natural Resources Environmental Protection Cabinet (NREPC) and as part of the RI. The Kentucky NREPC program was carried out in 1978 and consisted of the installation of eleven wells. Only five of the eleven wells could be located during the RI and four of these five wells had been previously sampled. Two of these five wells were dry at the time of the RI sample collection. The RI program installed and sampled five new wells on and around the site and six temporary well points along the Ohio River. Figure 4-8 shows the locations of the five Kentucky NREPC monitor wells, the five new wells and the six well points. Table 4-2 gives construction details for the monitor wells and well points that have been sampled.

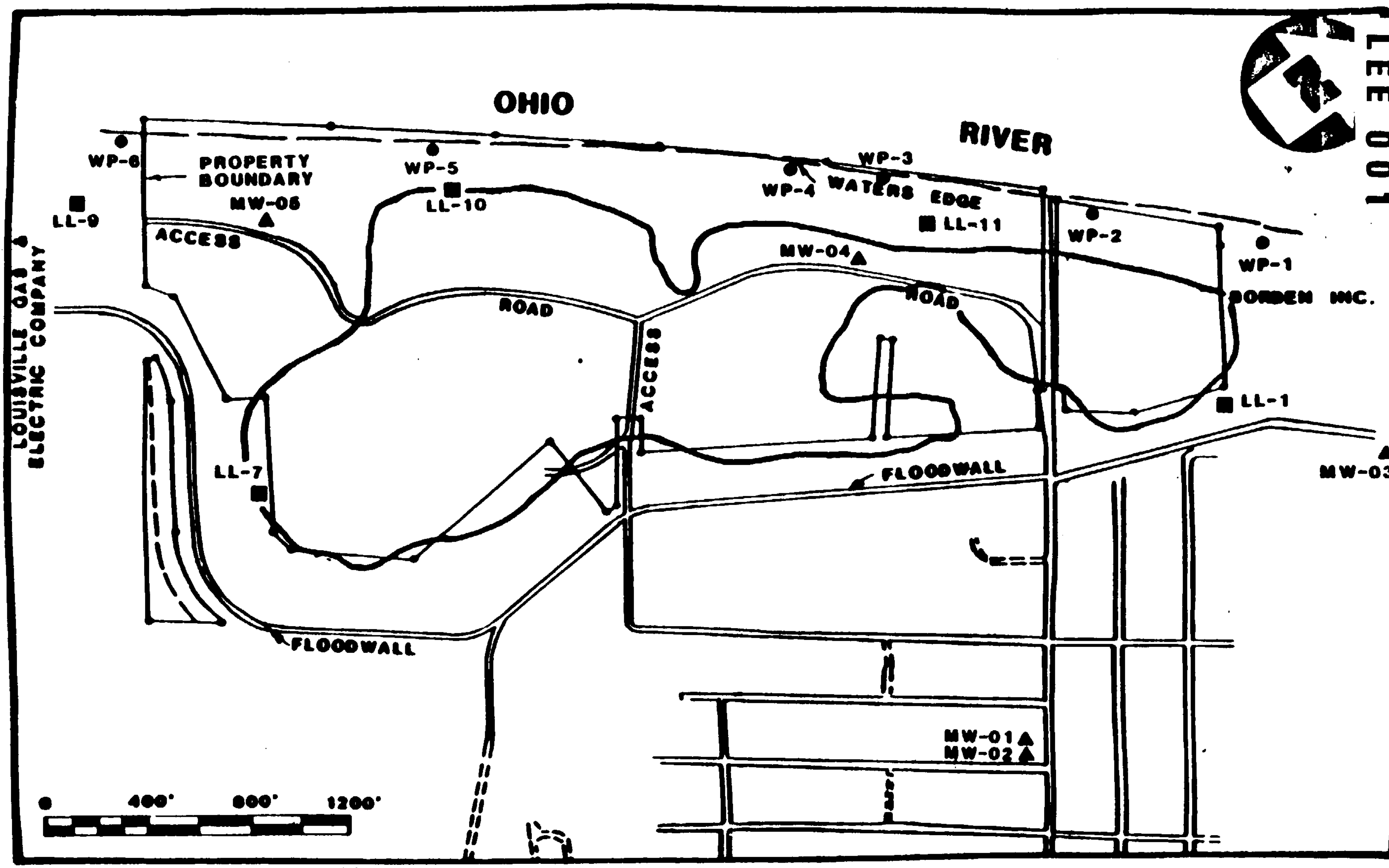
4.3.3.1 Kentucky NREPC Monitor Wells

In 1981, the State of Kentucky NREPC installed eleven shallow monitor wells on and around the landfill. The wells were constructed using 6-inch diameter PVC casing. The casing was hand slotted to provide a screened section and PVC glue and couplings were used to connect casing lengths (EPA, 1981). The wells have no bottom caps to prohibit sediments from entering the bottom of the well. Installation details for the Kentucky NREPC monitor wells are unknown. Based on past problems with excessive sediment in water samples, these wells were redeveloped by bailing. The wells were bailed dry and recharged quickly, but because the wells have no bottom caps, it was not possible to get totally sediment-free water.

4.3.3.2 Remedial Investigation Monitor Wells

In 1984, five additional monitor wells, one shallow and four deep, were installed at the site as part of the RI. A shallow well was installed to a depth of approximately 50 feet and four deep wells were installed near the top of bedrock, approximately 100 feet below land surface.

Two of the new monitor wells, one in the upper portion of the aquifer (MW-01) and one in the lower portion of the aquifer (MW-02), were installed upgradient of the



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MONITOR WELL AND
WELL POINT LOCATIONS
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

FIGURE 4-8

LEGEND

● - WELL POINT LOCATIONS

▲ - HI WELL LOCATIONS

■ - KENTUCKY NREPC WELL LOCATIONS

NUS CORPORATION
A Halliburton Company

TABLE 4-2
MONITOR WELL CONSTRUCTION DETAILS
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Well No.	Casing Material	Bottom of Well (ft)	Screen Length (ft)	Elevation Bottom of Well (msl)	Elevation Top of Well (msl)
Northern Tract					
LL-1	PVC	53	UNK	394.42	447.42
WP-2	SS	11.0	5	UNK	UNK
WP-1	SS	13.0	5	UNK	UNK
MW-03	SS	106	35	347.70	453.70*
Central Tract					
MW-01	SS	53	10	399.03	452.03*
LL-11	PVC	35		399.53	428.53*
WP-4	SS	10.4	5	UNK	UNK
WP-3	SS	10.7	5	UNK	UNK
MW-02	SS	98.5	5	353.87	452.37*
MW-04	SS	84.5	5	359.08	448.58*
Southern Tract					
LL-7	PVC	26	UNK	390.72	416.72*
LL-9	PVC	35.7	UNK	388.55	424.25*
WP-6	SS	10	5	UNK	UNK
WP-5	SS	10.2	5	UNK	UNK
MW-05	SS	86.5	35	343.28	429.78*

SS - Stainless Steel
UNK - Unknown
* - Surveyed as part of Remedial Investigation
LL - Kentucky NREPC Wells
WP - Well Point
MW - Newly installed monitor well

landfill in an empty lot in Riverside Gardens. These wells were designed to provide data on upgradient groundwater quality in the alluvial aquifer. Data from the upper well were used to determine if different flow zones are present and to provide upgradient data for comparison with the shallow Kentucky NREPC monitor wells downgradient. Data from the deeper well were used to provide upgradient data on groundwater quality above the bedrock surface and for comparison with downgradient wells installed during the RI.

Three other new wells were installed in and around the landfill in the lower portion of the alluvial aquifer. Two of these wells (MW-03 and MW-04) were equipped with continuous recording water level indicators. One well (MW-03) was installed northeast of the landfill between the levee and the Borden, Inc. property. Data from this well were used to determine the potential for landfill contaminants to migrate offsite through the alluvial aquifer toward nearby pumping centers. Another well (MW-04) was installed through the fill near the landfill's western border in the Central Tract. Data from this well were used to provide groundwater quality above the bedrock and downgradient of the majority of the landfill as well as to evaluate the potential for groundwater flow beneath the river. The last new well (MW-05) was installed in the Southern Tract of the landfill on the upper river terrace. Data from this well were used to provide groundwater quality above the bedrock and downgradient of the Southern Tract of the landfill.

The new monitor wells were constructed using schedule 5 stainless steel casing and screen. The casing and screen were 4-inch diameter with flush-joint, screw type connections. The screen slot size used was a No. 10 slot (0.010 inch).

In all of the new monitor wells the natural formation was allowed to collapse around the screen. An artificial sand pack was used when the natural collapse did not come to a sufficient height in the borehole. The natural collapse/sand pack was extended to at least four feet above the top of the well screen. A bentonite seal was installed on top of the sand pack in all of the wells except MW-01. The purpose of the bentonite seal was to keep cement from seeping into the well screen. The amount of formation collapse in well MW-01 was sufficient that migration of cement into the screen was not considered a problem. A neat cement/bentonite slurry was used to fill the remainder of the borehole to ground surface. A five foot steel protective casing with locking cap was cemented in place around each well head. Figure 4-9 shows typical monitor well construction for the wells installed as part of the RI. All the wells except MW-01 were developed using a submersible pump. Well MW-01 was developed by bailing. The wells were developed until the water being discharged was clear and free of sediment.

The groundwater monitoring wells sampled during the Remedial Investigation (including both existing and newly installed wells) were tied to the Kentucky State Plane Coordinate System, North Zone, by utilizing information from the property boundary survey conducted by AmTech Engineering, Inc., Consulting Engineers and Land Surveyors, Indianapolis, Indiana. The survey of the monitor wells was conducted by locating the wells relative to various property corners utilizing a Leitz/Sokkisha SDM3E. The State Plane coordinates of each well were then determined and the wells were plotted on the site topographic and planemetric maps. After the horizontal control of the monitoring wells was conducted, the wells were located vertically using an automatic level. All wells were tied into a benchmark approximately 50 feet north of Lees Lane on the levee wall. The benchmark is marked COE108 and was set by the Corps of Engineers. Its elevation is 460.25 feet.

Well completion reports and as-built well diagrams for the new wells are included with the well logs in Appendix D.

The shallow well points that were installed are discussed in Section 4.4.1.1.

4.3.4 Site Hydrogeology

The alluvial aquifer is the aquifer of concern at the site and consists of glacial outwash sands and gravel with intermittent silt and clay lenses. The depth to water below ground surface ranged from 30 feet at well MW-05 to 50 feet at well MW-02. The aquifer thickness is between 60 and 70 feet. Groundwater availability in the alluvial aquifer is good. The aquifer is capable of yielding 200 to 500 gallons per minute (gpm) to most wells that penetrate the full saturated thickness. There is a good hydraulic connection between the alluvium and the Ohio River and wells

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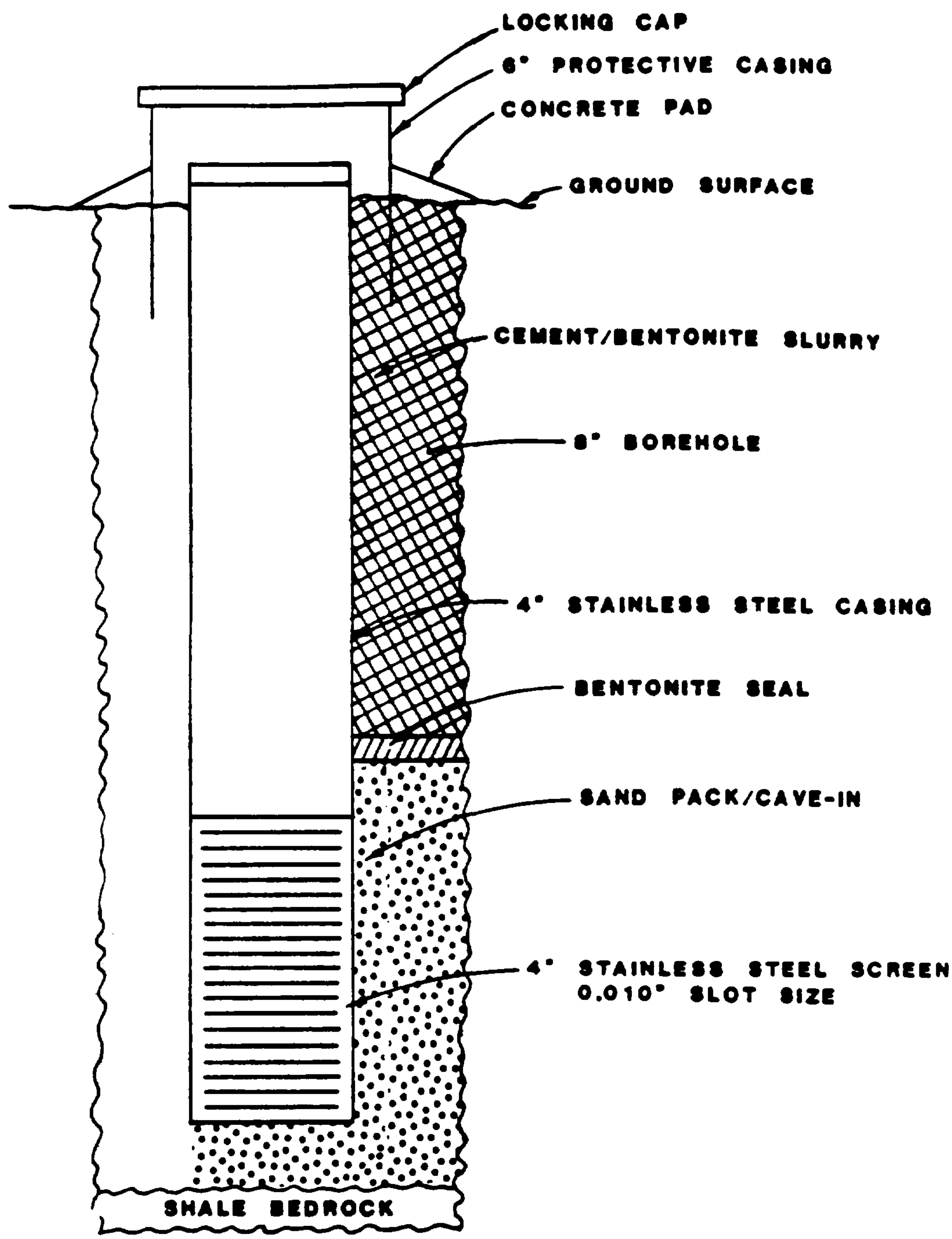


TYPICAL MONITOR WELL CONSTRUCTION
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

FIGURE 4-9

NUS CORPORATION
A Halliburton Company

along the river that pump at a high enough rate will induce infiltration from the river. The hydraulic connection between the alluvium and the river also affects groundwater levels. Groundwater levels are reported to fluctuate as much as 10 feet seasonally (EPA, 1982).

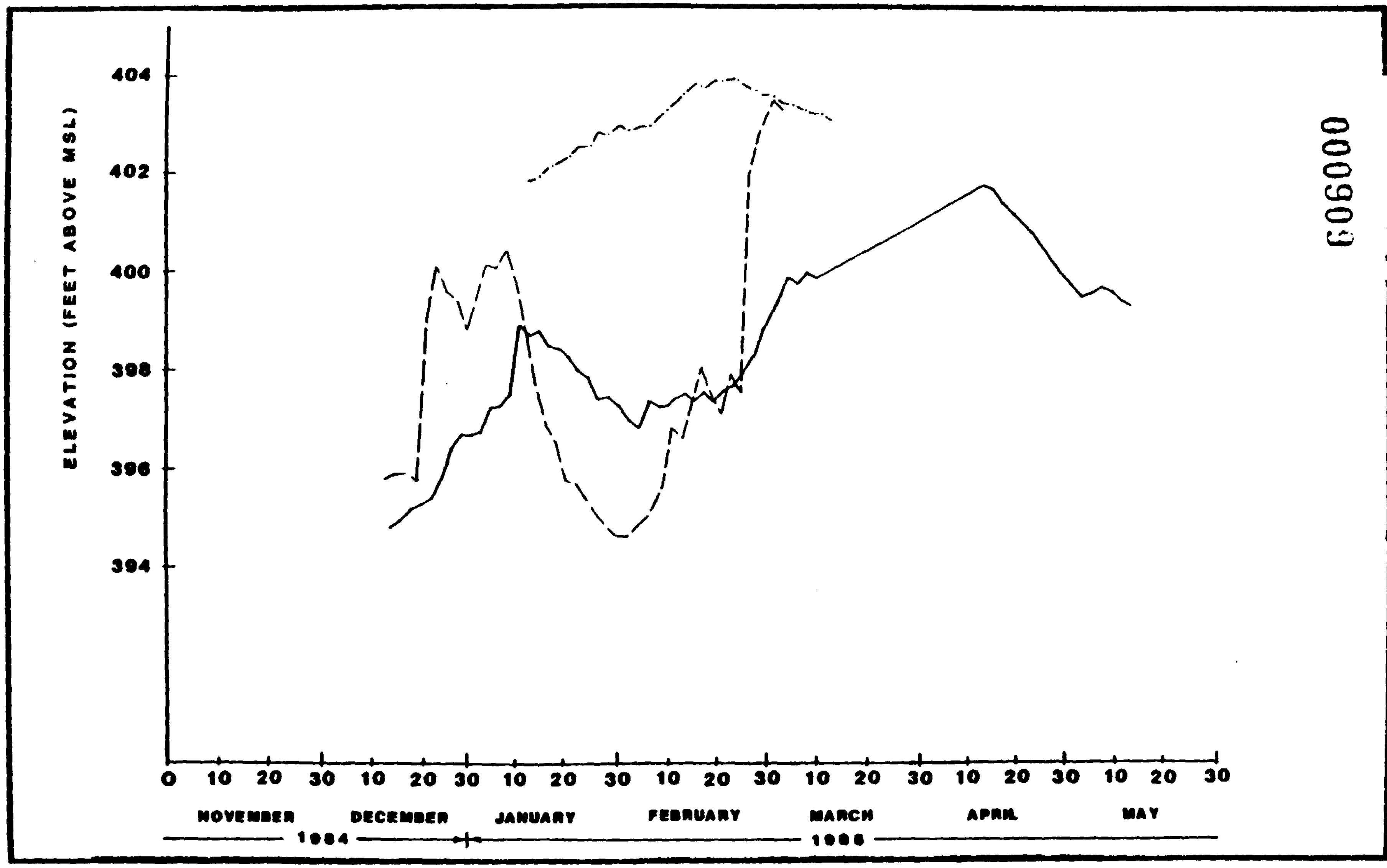
4.3.4.1 Water Level Recorders

Stevens Type F water level recorders were used to monitor fluctuations in groundwater levels at the site. The recorders were initially installed on wells MW-03 and MW-04. The recorder on well MW-04 was vandalized and subsequently moved to well MW-02. Figure 4-10 shows the hydrographs obtained from the water level recorders from December 1984 to May 1985.

River level data at the Kosmodale Station of the Ohio River was obtained from the Corps of Engineers. Figure 4-11 shows the hydrograph for the Ohio River from December 1984 to April 1985. The river reached its highest point during this period on March 1, 1985 at 416.9 feet msl and its lowest point on January 25, 1985 at 386.1 feet msl. The river water level was higher than the water level in the alluvial aquifer about 50 percent of the time during this period. Three major rises in the river water level can be seen on the hydrograph, one in late December, one in early March, and one in early April.

The recorder on well MW-02 was installed on March 11, 1985 and allowed to run until May 13, 1985. The hydrograph tracing from this well did not show as direct a response to Ohio River water levels as the other monitor wells but did exhibit a rising water level that corresponds to the seasonal high water period. The lowest water level noted was on March 13, 1985 at 401.9 feet msl and the highest was on April 23, 1985 at 404.0 feet msl.

The recorder on well MW-03 was installed on December 15, 1984 and allowed to run until May 13, 1985. The hydrograph tracing shows a direct correlation between groundwater levels and Ohio River water levels which indicates a direct hydraulic connection between the river and the aquifer and little or no affect of the pumping center to the northeast of the site. The lowest water level observed during the period that the water level recorder was in use was on December 15, 1984 and was



WATER - LEVELS
MW-02, MW-03, MW-04
LEES LANE LANDFILL SITE
JEFFERSON COUNTY , KENTUCKY

LEGEND

MW-02 — · — · —
MW-03 ————
MW-04 — — — —

FIGURE 4-10

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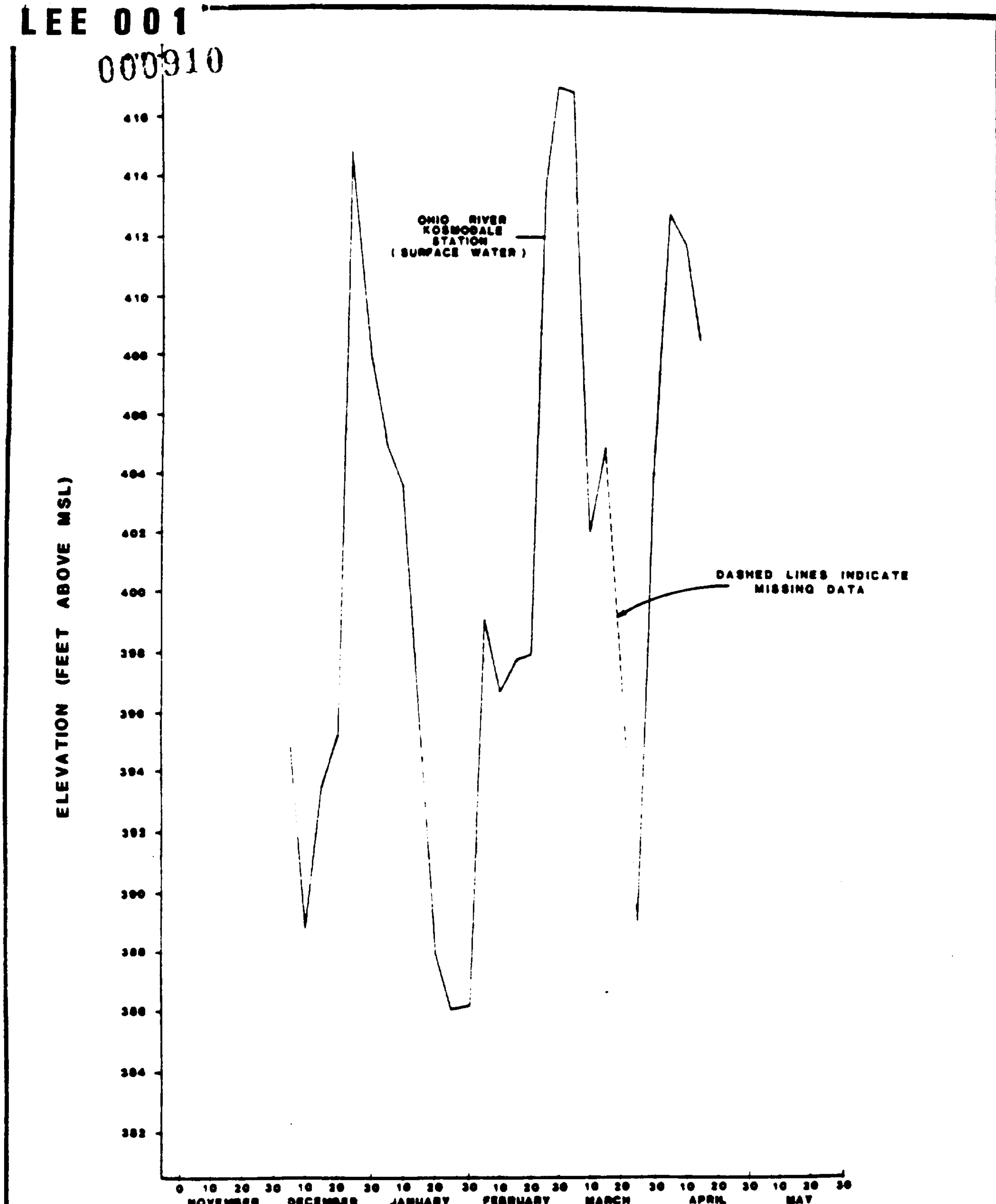

SOURCE: COE, 1985

OHIO RIVER WATER LEVELS
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

FIGURE 4-11

NUS CORPORATION
A Halliburton Company

recorded at 394.8 feet msl. The highest level noted was on April 13, 1985 and was recorded at 401.8 feet msl.

The recorder on well MW-04 was installed on December 15, 1984 and moved to well MW-02 on March 11, 1985. The hydrograph tracing for MW-04 also showed a direct correlation with Ohio River water levels. The lowest water level observed in this well occurred on January 31, 1985 at 394.5 feet msl and the highest on March 2, 1985 at 403.4 feet msl.

4.3.4.2 In-Situ Hydraulic Conductivity Testing

In-situ hydraulic conductivity tests were performed on the four deep monitoring wells at the Lees Lane Landfill Site. The shallow monitor well did not contain enough water to allow testing. Tests performed on the monitoring wells included both "rising head" and "falling head" hydraulic conductivity tests. Both rising head and falling head tests were performed using a 2.5-inch diameter, stainless steel cylinder, 10 feet long and closed on both ends. This "slug" was calculated to displace a volume equal to four feet of water in a four-inch diameter well. The falling head tests conducted at the site involved the addition of the slug of known volume and measurement of water level decline over time. Rising head tests are the opposite of falling head tests and involve the removal of the slug from the well and measurement of water level recovery in the well over time.

An In-Situ, Inc., Model SE1000, Pressure Transducer was used to measure the water level recovery or decline in the monitor wells. The pressure transducer was installed in the well so that it was situated across the screened interval. During the tests, the stainless steel slug was introduced and removed from the well as rapidly as possible. The SE1000 is designed to take water level readings at designated intervals which were then played back and recorded. Coefficient of Permeability values were then determined by using the Hvorslev method (Hvorslev, 1951).

The results of the tests showed permeability values ranging from 2.46×10^{-2} centimeters per second (cm/sec) to 8.9×10^{-3} cm/sec. which correspond to published literature values. Plots of the test results and calculations are included in Appendix E.

4.3.4.3 Groundwater Flow Direction

Table 4-3 lists water levels measured during the RI in the three Kentucky NREPC monitor wells, the five new monitor wells, and the Ohio River. Water levels in all the wells except LL-11 are consistent. The water level in LL-11 was much higher than the other wells and at times was higher than the water level in the Ohio River. An examination of the data indicated that well LL-11 responded directly to a rise in river water level but did not directly respond to a fall in river water level. The lack of response to falling water levels is most likely caused by well inefficiency due to the well slotted section being silted-in. This is consistent with known well construction details. This is also consistent with observations made in well MW-04 where rising water levels cause a direct response and falling water levels show a delayed response. However, the delay time in well LL-11 was thought to be much too long to be considered normal.

The water level measurements recorded during the RI were compared to investigate the groundwater response time to changes in the Ohio River and to assess groundwater flow direction. The highest level recorded in MW-04 was on March 2, one day after the peak in the Ohio River. The lowest level recorded in MW-04 was on January 31, six days after the lowest level in the Ohio River. A comparison of the groundwater contours shown in Figures 4-12 through 4-14 indicates the gradient changes in direct response to changes in the Ohio River water levels. During this period, the water level in the Ohio River changed from 402 feet above mean sea level (amsl) in early January to 398 feet amsl in early February and back to 402 feet amsl in mid-March. A closer examination of the water level in LL-7 indicates little change from early February to mid-March (402.47 to 402.59 feet amsl, respectively) suggesting that the apparent change in gradient in the Southern Tract is the result of changing water levels in the monitor wells near the River. Conversely, the water level in MW-02 changed slightly over a foot from early February to mid-March (see Table 4-3) suggesting that the apparent change in gradient in the Central and Northern Tracts is the result of changing water levels throughout the landfill.

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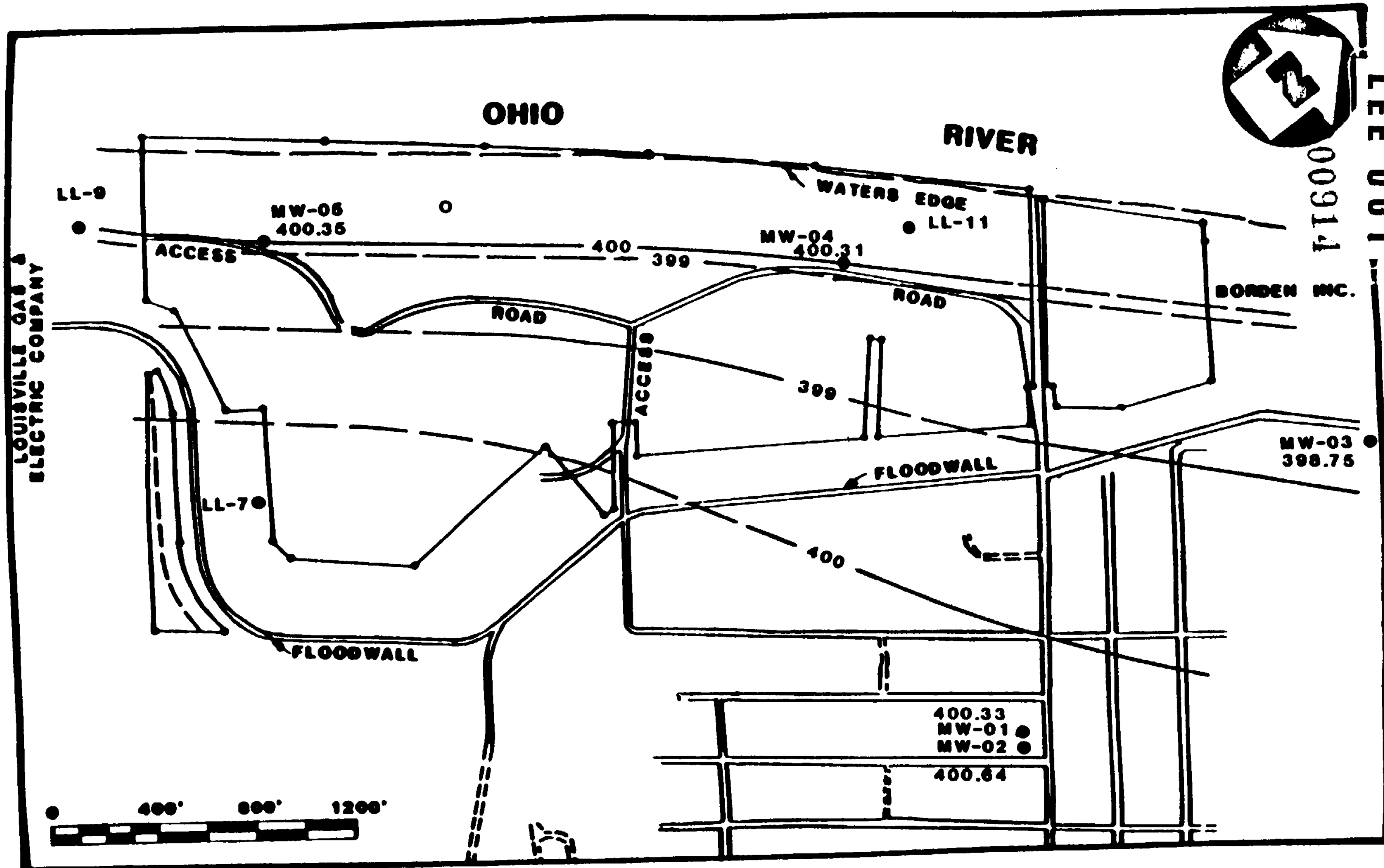
TABLE 4-3
GROUNDWATER ELEVATIONS
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Well #	11/27/84	12/4-8/84	1/8-9/85	2/8/85	3/11/85	4/11/85	5/13/85
LL-7	396.82	397.47		402.47	402.59	403.92	398.98
LL-9	393.37	394.15		395.15	400.80	402.59	394.66
LL-11	396.03	395.17		401.62	407.90	410.07	404.19
MW-01		400.57	400.33	399.93	401.83	403.21	402.81
MW-02		401.04	400.64	400.99	402.02	403.47	403.13
MW-03		396.54	398.75	397.31	400.02	401.89	399.34
MW-04		396.79	400.31	396.63	401.02	402.31	395.64
MW-05		395.90	400.35	395.55	401.28	402.70	395.10
Ohio River				397.7	402.55	411.3	

Note: All readings are in feet and referenced to mean sea level (msl)



GROUNDWATER CONTOURS

JANUARY 8 & 9, 1985

LEES LANE LANDFILL SITE

JEFFERSON COUNTY, KENTUCKY

FIGURE 4-12

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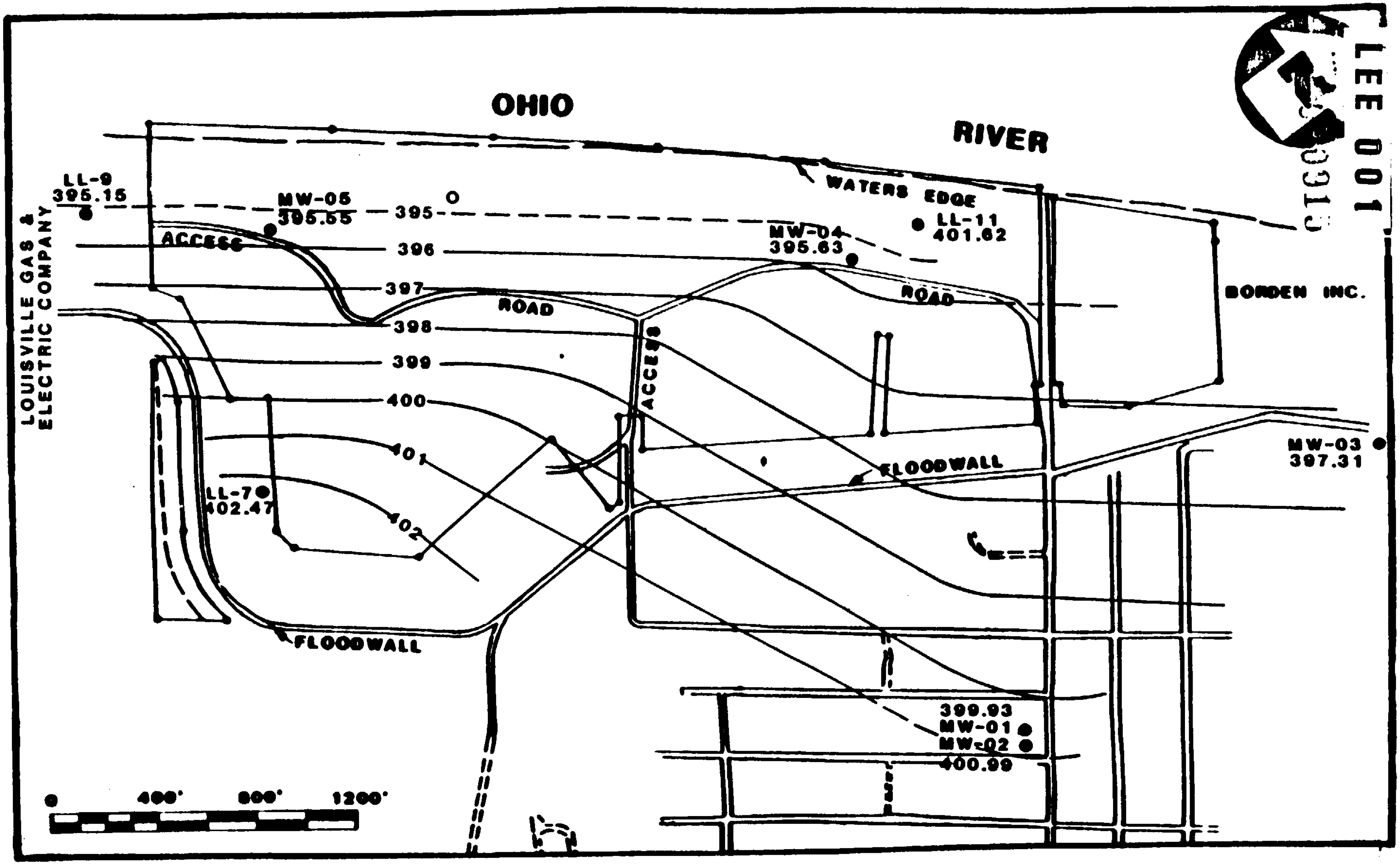

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GROUNDWATER CONTOURS
FEBURARY 8, 1985
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

FIGURE 4-13

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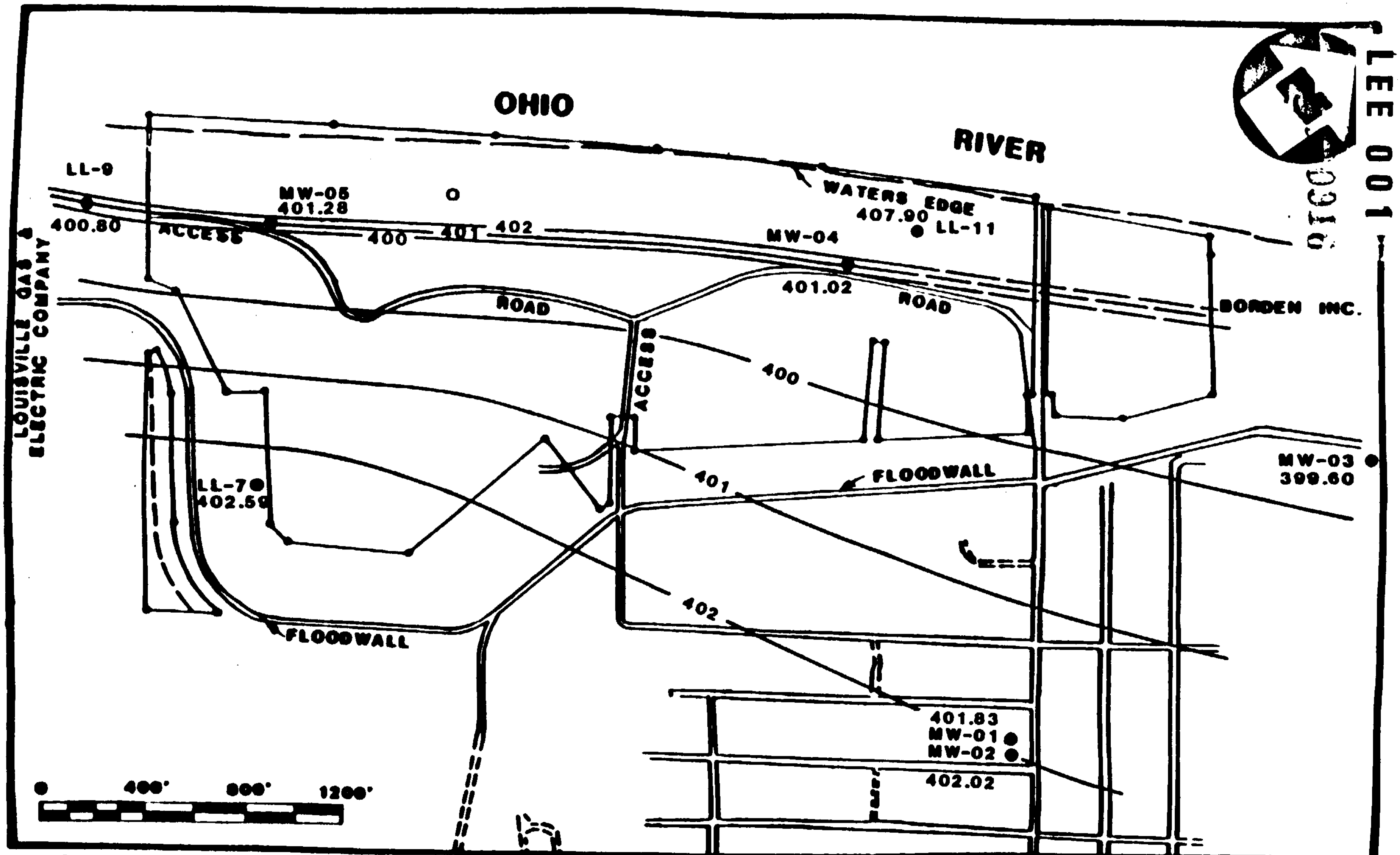

GROUNDWATER CONTOURS
MARCH 11, 1985
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

FIGURE 4-14

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To investigate this hypothesis further, the hydrographs for MW-04 and MW-03 were compared. MW-03 is located approximately 800 feet from the Ohio River to the east of the Northern Tract. MW-04 is located approximately 350 feet from the Ohio River in the middle of the Central Tract. A comparison of the hydrographs for these two wells in late December and early January suggests that although MW-04 responded almost immediately to the peak in the Ohio River, MW-03 required approximately 18 days to reach its peak water level. During this period, the water level in MW-04 was higher than the water level in MW-03 by up to four feet, suggesting the potential for flow reversal. A similar comparison of the water levels measured in MW-04 and MW-03 on April 11 (402.31 and 401.89 feet amsl, respectively) suggests that the potential for flow reversal again existed.

The principles of flow reversal and bank storage at the Lees Lane Landfill Site were carefully evaluated to determine the potential for groundwater reversal into Riverside Gardens. These principles can be best illustrated through a site-specific example. As the water level of the Ohio River rises above the water level of the groundwater discharging to the river, the potential for groundwater reversal is created. The greater the duration and higher the water level of the Ohio river, the greater the potential for groundwater reverse flow. The real concern, however, is the potential for the reverse migration of contaminants from the landfill into Riverside Gardens private water supplies from the alluvial aquifer. Since the groundwater upgradient of the site will continue to flow towards the river, even under groundwater reversal conditions, this groundwater will ultimately flow into the reversing groundwater flow. Under these conditions, the groundwater flowing toward the river will act as a barrier to the flow of the reversing groundwater and a small mound of groundwater will be temporarily formed. This small mound is referred to as bank storage since it usually occurs near the banks of streams as a result of rising surface water levels. As the river level drops, this mound will flow toward the river, but the response will be slightly slower than if the water table were an inclined plane as is usually the case.

It is difficult to predict the water levels and duration necessary in the Ohio River to cause flow reversal into Riverside Gardens. However, during the lowest water levels measured in the upgradient monitor wells in Riverside Gardens, the elevation of the water table was approximately 400 feet amsl. The bank of the Ohio River is between 400 and 425 feet amsl. If the Ohio River were to rise to 400 feet amsl, the water level in the groundwater would also rise to some extent. But assuming worst case conditions and the water table remained stable at 400 feet, the groundwater table would still be flat and reversal to Riverside Gardens would not occur. Under the 100-year flood conditions, the water level in the Ohio River rises to 447 feet amsl and inundates some of the site. Considering the land surface at the upgradient well is approximately 450 feet amsl and the water levels measured during the RI were approximately 50 feet below the land surface, it is possible that groundwater reversal could occur under the 100-year flood conditions. However, even under these potential reverse flow conditions, groundwater contaminants may not migrate to any great extent since the concentration in the groundwater would be significantly reduced as a result of dilution.

Extensive groundwater flow reversal conditions have not been established at the site, but conditions that could contribute to flow reversal have been observed. However, the duration of time that these conditions exist is short and fluctuate over the period that the Ohio River experiences high water stages. In order for groundwater flow reversal to reach Riverside Gardens, the conditions necessary for flow reversal would have to be present for a long period of time. This is extremely unlikely; and therefore, flow reversal to Riverside Gardens is also very unlikely. A detailed study over several years would be necessary to establish the limits of potential groundwater flow reversal.

4.3.4.4 Groundwater Travel Time

The water level contour maps developed for the site, indicate that the groundwater flow is approximately perpendicular to the Ohio River. The time necessary for groundwater to travel beneath the site was estimated based on the maximum groundwater flow rate during the RI. The estimated travel time assumed the highest permeability (K) value determined from the in-situ testing, the highest hydraulic gradient (I), and an average porosity (n) of 40 percent from the literature. The distance beneath the site is the width of the landfill.

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Permeability (K) = 2.4×10^4 ft/yr

Hydraulic Gradient (I) = .007

Porosity (n) = 0.40

Distance (D) = 1,500 feet

$$V_{GW} = \frac{KI}{n}$$

$$= \frac{2.4 \times 10^4 \text{ ft/yr} \times .007}{0.4}$$

$$= 420 \text{ ft/yr}$$

$$\text{Travel Time} = \frac{D}{V_{GW}}$$

$$= \frac{1500 \text{ ft}}{420 \text{ ft/yr}}$$

$$= 3.6 \text{ years}$$

4.3.4.5 Ohio River Dilution Factor

Through the evaluation of the hydrogeology at the site it was determined that the majority of groundwater flow is into the Ohio River. In order to determine the worst case for potential groundwater contaminants to enter the Ohio River, the highest permeability value obtained through the in-situ testing and the highest hydraulic gradient were used to calculate groundwater flow. The data used to estimate the dilution factor is as follows:

Permeability (K) = 2.46×10^{-2} cm/sec. = 8.07×10^{-4} ft/sec

Hydraulic gradient (I) = .007

Area (A) = 60 feet x 5000 feet = 300,000 ft^2

Ohio River flow (Qo) = 114,000 ft^3/sec

$$Q_{GW} = KIA$$

$$= 8.07 \times 10^{-4} \text{ ft/sec} \times .007 \times 300,000 \text{ ft}^2$$

$$= 1.69 \text{ ft}^3\text{/sec}$$

Dilution rate $= \frac{Q_o}{Q_{GW}}$

$= \frac{114{,}000 \text{ ft}^3/\text{sec}}{1.69 \text{ ft}^3/\text{sec}}$

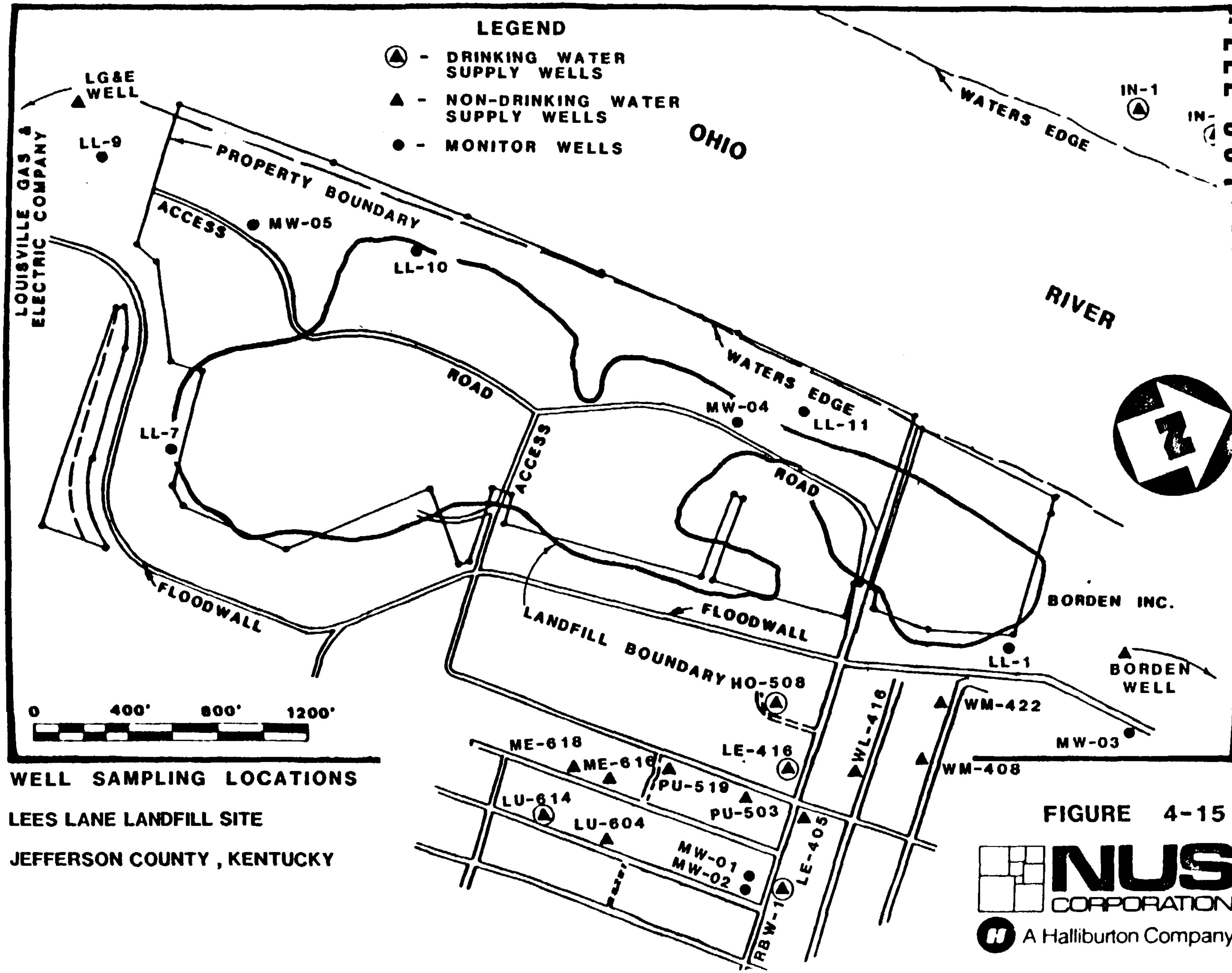
$=$ 67,456 to 1

4.4 Sampling Program

A groundwater sampling program consisting of onsite and offsite groundwater samples was conducted during the RI. All samples collected were analyzed for the Hazardous Substance List (HSL) and other selected parameters listed in Appendix F. The analyses were conducted by EPA's National Contract Laboratory Program (CLP). The onsite groundwater samples were collected from monitor wells and well points along the Ohio River to determine the presence or probable absence of contamination and to evaluate any potentially preferred groundwater pathways. The offsite groundwater samples were collected from residential and industrial wells, a public water supply well field, and upgradient monitor wells. The offsite groundwater samples were used to determine the background groundwater quality in the alluvial aquifer upgradient of the site and to investigate groundwater migration routes. The sample location descriptions can be found in Appendix G and the well sampling locations are shown on Figure 4-15.

4.4.1 Onsite Groundwater

The onsite groundwater sampling program was designed to determine the presence or probable absence of contaminants in the alluvial aquifer beneath the site. The analytical results were used to evaluate the potential for contaminant migration away from the site via the alluvial aquifer toward a nearby industrial pumping center, into the Ohio River, toward Riverside Gardens, and beneath the Ohio River toward public water supply wells in Indiana. The onsite groundwater sampling program included three wells, MW-01, MW-02, and MW-03, not located on the landfill. Wells MW-01 and MW-02 were upgradient wells used for comparison



WELL SAMPLING LOCATIONS

LEES LANE LANDFILL SITE

JEFFERSON COUNTY, KENTUCKY

FIGURE 4-15

NUS CORPORATION

A Halliburton Company

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purposes and well MW-03 was northeast of the landfill and used to evaluate the potential effects from the industrial pumping center.

4.4.1.1 Shallow Well Point Samples

Six temporary well points were installed and sampled on the lower Ohio River bank terrace. Analytical results from the shallow well point samples were used to determine the presence or probable absence of contaminants in groundwater or leachate being discharged to the Ohio River. The well points were located near areas where leachate seeps had been observed in the past. The field sampling data can be found in Appendix H.

The six well points were installed using a hand-held gasoline powered auger. The well points were constructed of clean Type 304 stainless steel, two-inch inside diameter casing, with one 2-foot section of 0.01 inch slotted screen. They were installed to a depth of ten to thirteen feet, depending on where water was encountered. An attempt was made to purge the well points with a peristaltic pump until the conductivity stabilized or until the water appeared relatively free of sediment. This was not always possible because the well points often ran dry after a short period of purging. The samples were then collected with a teflon bailer. The water in the bailer was evenly portioned into each sample container after every bail. All reuseable equipment was decontaminated prior to sampling each well point. Clean teflon tubing for the pump and new bailing rope were used for each well point.

4.4.1.2 Monitor Wells

In April 1981 the Surveillance and Analysis Division (SAD), EPA Region IV sampled five of the Kentucky NREPC wells. The wells sampled were: LL-1, LL-7, LL-9, LL-10, and LL-11. Problems were encountered with the samples due to large quantities of sediment. The analytical results were thought to be elevated due to the sediment problem.

All of the newly installed monitor wells in addition to three wells (LL-7, LL-9, and LL-11) previously installed by the Kentucky NREPC were sampled during the RI.

The three Kentucky NREPC monitor wells were screened to a maximum depth of 35.7 feet below land surface and analytical results from the groundwater samples were used to provide onsite groundwater quality information on the upper portion of the alluvial aquifer. Two of the five previously sampled monitor wells installed by the Kentucky NREPC could not be sampled during the RI. Well LL-1 could not be located and well LL-10 was damaged and uncapped.

The three onsite Kentucky NREPC monitor wells were bailed dry one week prior to sampling and once again immediately before sampling. After recharging, the wells were sampled. The field sampling data can be found in Appendix H and the analytical results of the groundwater samples collected from the top of the aquifer in 1981 and in 1984 are presented by tract in Tables 4-4 through 4-7.

Each of the five newly installed wells were purged three to five well volumes of water or until the well was dry prior to sampling. A clean submersible pump was used and was lowered down the well to just below the water surface. This insured that as much of the water column in the well as possible would be removed. During purging, the pump was continually lowered as the water level dropped. The water level in each well was measured before and after purging. After the well recharged to the static water level, a groundwater sample was collected. The field sampling data can be found in Appendix H and the analytical results are presented in Tables 4-8 and 4-9.

4.4.2 Offsite Groundwater

The offsite groundwater sampling program was designed to compliment the onsite monitoring network and the temporary well point sample locations. The samples collected during the RI were analyzed for the same parameters as the onsite wells and the analytical results were used to evaluate the presence or probable absence of contaminants and potential migration pathways.

Two deep industrial wells screened at the bottom of the alluvial aquifer and located near the landfill were sampled in December 1984. The analytical results from the Borden, Inc. well (BW-1), located approximately 1/4 mile northeast of the landfill boundary, were used to determine the presence or probable absence of

TABLE 4-4
SUMMARY OF ANALYTICAL RESULTS OF GROUNDWATER SAMPLES
NORTHERN TRACT - TOP OF AQUIFER
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Parameter in ug/l	Upgradient MW-1 12/84	East of Fill LL-1 4/81	Downgradient - at Ohio River WP-1 11/84	Downgradient - at Ohio River WP-2 11/84
Inorganics				
Arsenic	-	-	-	50J
Boron	NA	920	NA	NA
Barium	56	360	210	400
Cobalt	-	20	-	-
Chromium	43	40	29	-
Copper	35	120	30	-
Nickel	47	80	41	-
Lead	7.2	40	83	23
Vanadium	-	30	-	-
Zinc	57	260	160	45
Aluminum	1,800	12,800	16,000	3,100
Manganese	300	1,910	1,400	1,700
Calcium	130,000	NR	130,000	220,000
Magnesium	43,000	46,300	37,000	44,000
Iron	5,200	25,800	25,000	47,000
Sodium	41,000	105,000	16,000	35,000
Potassium	2,200	NR	-	9,900
Bicarbonate (as HCO_3 ion)	170,000	NR	NA	NA
Chloride	22,000	NR	NA	NA
Sulfate	91,000	NR	NA	NA
Extractable Organics				
Unidentified Compound	-	NR	1-30J	-
Purgeable Organics				
2-Propanol	-	NR	20JN	-
Propanol	-	NR	-	200JN

-   Not detected.
J   Estimated value.
NA   Not analyzed.
NR   No data reported.
N   Presumptive evidence of presence of material.

TABLE 4-5
SUMMARY OF ANALYTICAL RESULTS OF GROUNDWATER SAMPLES
MONITOR WELLS - CENTRAL TRACT - TOP OF AQUIFER
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

	Upgradient	Onsite		Downgradient at Ohio River	
	MW-1	LL-11		WP-3	WP-4
Parameter in ug/l	12/84	4/81	12/84	11/84	11/84
Inorganics					
Arsenic	-	120	10	60J	20J
Boron	NA	400	NA	NA	NA
Barium	56	1,340	270	470	400
Beryllium	-	10	-	-	-
Cadmium	-	5	-	-	-
Cobalt	-	140	26	-	-
Chromium	43	180	19	-	29
Copper	35	220	41	-	42
Molybdenum	NA	NR	NA	NA	NA
Nickel	47	280	45	-	55
Lead	7.2	160	47	21	17
Selenium	-	100	-	-	-
Tin	-	50	-	-	-
Vanadium	-	230	53	-	-
Zinc	57	1,120	240	58	260
Mercury	-	1	-	-	-
Aluminum	1,800	138,000	17,000	3,300	15,000
Manganese	300	16,800	7,300	1,300	2,200
Calcium	130,000	NR	190,000	220,000	170,000
Magnesium	43,000	64,400	63,000	44,000	39,000
Iron	5,200	297,000	32,000	60,000	57,000
Sodium	41,000	32,200	31,000	35,000	49,000
Potassium	2,200	NR	6,500	-	5,600
Bicarbonate (as HCO_3 ion)	170,000	NR	380,000	NA	NA
Chloride	22,000	NR	16,000	NA	NA
Sulfate	91,000	NR	100,000	NA	NA
Extractable Organics					
Phenol	-	32	R	27J	-
Pentanoic Acid	-	NR	-	-	7JN
Octanoic Acid	-	NR	-	-	6JN
Benzeneacetic Acid	-	NR	-	-	10JN
Dodecanoic Acid	-	NR	-	-	20JN
Tetradecanoic Acid	-	NR	-	-	5JN
Unidentified Compounds	-	NR	1-20J	1-10J	3-40J
Purgeable Organics					
Benzene	-	-	-	450	-
2-Propanol	-	NR	100JN	70JN	300JN

- \- Not detected.
- J Estimated value.
- NA Not analyzed.
- NR No data reported.
- N Presumptive evidence of presence of material.
- R Quality control indicates are unuseable.

LEE 001 00092[illegible]

TABLE 4-6
SUMMARY OF INORGANIC ANALYTICAL RESULTS OF GROUNDWATER SAMPLES
SOUTHERN TRACT - TOP OF AQUIFER
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

	Upgradient	Onsite			SW of Fill		Downgradient at Ohio River	
	MW-1	LL-7		LL-10	LL-9		WP-5	WP-6
	12/84	4/81	12/84	4/81	4/81	12/84	11/84	11/84
Parameter in ug/l								
Inorganic								
Arsenic	-	140	-	900	700	87	-	-
Boron	NA	120	NA	420	330	NA	NA	NA
Barium	56	1,310	96	19,700	4,850	880	390	220
Beryllium	-	-	-	168	56	10	-	-
Cadmium	-	-	-	30	15	22	5.8	-
Cobalt	-	590	-	2,220	1,040	160	-	-
Chromium	43	130	12	2,320	900	140	22	33
Copper	35	380	-	2,960	1,440	220	-	-
Nickel	47	900	30	3,420	1,580	260	-	46
Lead	7.2	-	-	-	-	150	20	18
Selenium	-	-	-	1,000	400	-	NAI	NAI
Tin	-	30	-	30	40	-	-	-
Thallium	-	-	-	10	20	-	-	-
Vanadium	-	170	-	2,420	1,300	270	-	-
Zinc	57	830	100	10,700	4,260	710	110	140
Mercury	-	-	-	5	2	-	-	-
Aluminum	1,800	51,200	1,400	1,920,000	667,000	85,000	8,400	21,000
Manganese	300	36,100	2,200	216,000	37,600	7,900	5,100	940
Calcium	130,000	NR	100,000	NR	NR	350,000	170,000	44,000
Magnesium	43,000	348,000	32,000	641,000	482,000	150,000	37,000	18,000
Iron	5,200	191,000	3,700	5,180,000	1,750,000	190,000	40,000	34,000
Sodium	41,000	14,400	18,000	89,800	71,400	12,000	63,000	-

TABLE 4-6
SUMMARY OF INORGANIC ANALYTICAL RESULTS OF GROUNDWATER SAMPLES
SOUTHERN TRACT - TOP OF AQUIFER
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY
PAGE TWO

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000927

	Upgradient	Onsite			SW of Fill		Downgradient at Ohio River	
	MW-1	LL-7		LL-10	LL-9		WP-5	WP-6
	12/84	4/81	12/84	4/81	4/81	12/84	11/84	11/84
Parameter in ug/l								
Inorganic								
Potassium	2,200	NR	6,400	NR	NR	19,000	-	-
Bicarbonate (AS HCO_3 Ion)	170,000	NR	200,000	NR	NR	310,000	NA	NA
Chloride	22,000	NR	26,000	NR	NR	21,000	NA	NA
Sulfate	91,000	NR	63,000	NR	NR	75,000	NA	NA

- Not detected.
NA Not analyzed.
NAI Interferences.
NR No data reported.

TABLE 4-7
SUMMARY OF ORGANIC ANALYTICAL RESULTS OF GROUNDWATER SAMPLES
SOUTHERN TRACT - TOP OF AQUIFER
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Parameter in ug/l	Upgradient	Onsite			SW of Fill		Downgradient at Ohio River	
	MW-1	LL-7		LL-10	LL-9		WP-5	WP-6
	12/84	4/81	12/84	4/81	4/81	12/84	11/84	11/84
Extractable Organics								
Bis (2-ethylhexyl) Phthalate	-	-	-	15	-	1J	-	-
Hexahydroazepinone	-	NR	50JN	NR	NR	5JN	-	-
Butenoic Acid	-	NR	-	NR	NR	10JN	-	-
Methylpentanoic Acid	-	NR	-	NR	NR	6J	-	-
Hexanoic Acid	-	NR	-	NR	NR	10JN	-	-
Octanoic Acid	-	NR	-	NR	NR	9JN	-	-
Dodecanoic Acid	-	NR	-	NR	NR	4JN	-	-
Hexadecenoic Acid	-	NR	-	NR	NR	10JN	-	-
Unidentified Compounds	-	NR	1-10J	NR	NR	12-200J	2-20J	-
Purgeable Organics								
Butanol	-	NR	-	NR		10JN	-	-
2-Propanol	-	NR	-	NR		-	20JN	-
Methyl Ethyl Ketone	-	NR	-	NR		30J	-	-
Butanoic Acid, Ethyl Ester	-	NR	-	NR		50JN	50JN	-
Butanoic Acid, Butyl Ester	-	NR	-	NR		20JN	20JN	-
Trichlorofluoromethane	NA	-	NA	-	10K	NA	NA	NA
Dichlorodifluoromethane	NA	-	NA	-	10K	NA	NA	NA
Carbon disulfide	-		-				49	

- Not detected.
J Estimated value.
NR No data reported.
N Presumptive evidence of presence of material.
K Compound was identified at present but at a concentration less than detection limits.

LEE 001
000928

LEE 001 000923

TABLE 4-8
SUMMARY OF INORGANIC ANALYTICAL RESULTS OF GROUNDWATER SAMPLES
MONITOR WELLS - BOTTOM OF AQUIFER
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

	Upgradient		Northern Tract East of Fill		Central Tract Onsite		Southern Tract Onsite	
	MW-2		MW-3		MW-4		MW-5	
Parameter in ug/l	12/84	1/85	12/84	1/85	12/84	1/85	12/84	1/85
Inorganics								
Arsenic	-	-	-	4.3	-	7.3	-	8.1
Barium	58	71	81	130	180	210	1,100	790
Cobalt	-	-	-	6.6	-	-	31	14
Chromium	120	57J	640	210	230	30J	360	400
Copper	91	43	170	61	74	27	55	59
Nickel	66	37	340	110	130	16	220	220
Lead	28	23J	20	68J	15	17J	11	44J
Zinc	100	130	120	150	110	32J	120	160
Aluminum	540	260	1,100	290	740	180	420	470
Manganese	93	230J	740	420J	830	900J	44,000	3,400J
Calcium	25,000	50,000	78,000	75,000	93,000	92,000	130,000	74,000
Magnesium	8,600	14,000	18,000	23,000	33,000	36,000	12,000	35,000
Iron	2,400	1,900	9,100	6,000	11,000	17,000	4,200	11,000
Sodium	38,000	24,000J	20,000	16,000J	39,000	33,000J	55,000	63,000J
Potassium	61,000	27,000	15,000	3,600	17,000	8,200	12,000	24,000
Bicarbonate (as HCO_3 ion)	180,000	NA	110,000	NA	180,000	NA	300,000	NA
Carbonate (as CO_3 ion)	59,000	NA	-	NA	-	NA	-	NA
Chloride	28,000	NA	19,000	NA	34,000	NA	63,000	NA
Sulfate	89,000	NA	57,000	NA	100,000	NA	26,000	NA

-    Not detected.
J   Estimated value.
NA   Not analyzed.

TABLE 4-9
SUMMARY OF ORGANIC ANALYTICAL RESULTS OF GROUNDWATER SAMPLES
MONITOR WELLS - BOTTOM OF AQUIFER
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Parameter in ug/l	Upgradient MW-2 12/84	Upgradient MW-2 1/85	Northern Tract East of Fill MW-3 12/84	Northern Tract East of Fill MW-3 1/85	Central Tract Onsite MW-4 12/84	Central Tract Onsite MW-4 1/85	Southern Tract Onsite MW-5 12/84	Southern Tract Onsite MW-5 1/85
Extractable Organics								
Di-N- Butylphthalate	-	-	8	-	-	-	-	-
Bis 2-(Ethylhexyl) Phthalate	20J	-	5	-	5	-	20	-
Phenol	300J	76	-	-	-	-	-	20J
4-Methylphenol	-	2J	-	-	-	-	R	-
Ethylhexanoic Acid	10JN	-	-	-	-	-	10JN	-
Benzoic Acid	-	-	-	-	-	2J	R	-
Unidentified Compounds	-	-	3-100J	-	-	-	-	-
Purgeable Organics								
Chloroform	5J	-	-	-	-	-	-	-
Benzene	-	20	-	-	-	-	-	-
Toluene	10J	-	-	-	-	-	-	-
Propanol	100JN	-	-	-	-	-	-	-
Ethanol	10JN	-	-	-	30JN	-	-	-
2-Propanol	-	-	20JN	-	100JN	-	-	-
Methyl Ethyl Ketone	-	-	10J	-	-	-	-	-
Dichlorofluoromethane	-	-	-	-	-	-	6JN	-
Methyldioxolane	-	-	-	-	-	-	5JN	-
Carbon Disulfide	-	13	-	15	-	-	-	-

- Not detected.
J Estimated value.
R Quality control indicates that data are unuseable.
N Presumptive evidence of presence of material.

LEE 001 000930

contaminants as a result of potential plume migration induced by pumping. Results from the Louisville Gas and Electric Company well (LW-2), located approximately 1/3 mile south of the landfill, were used to determine the presence or probable absence of contaminants and to evaluate the potential for contaminant migration.

Two deep (greater than 100 feet) public water supply wells screened in the lower part of the alluvial aquifer were also sampled during the RI. The wells, operated by Edwardsville Water Corporation and located in Floyd County, Indiana, provided groundwater quality information in the alluvial aquifer immediately above the bedrock across the Ohio River. The analytical results were used to evaluate the potential for groundwater contaminants to move from the landfill and under the Ohio River.

The samples from the Borden Inc. well and the Louisville Gas and Electric well were collected from an outside spigot. Water from these wells was flushed for several minutes prior to sampling in order to allow the specific conductivity to stabilize. The samples from the two public water supply wells in Indiana were collected from spigots in an underground well house. Well IN-1 was allowed to run before sampling until a stable conductivity was obtained. Well IN-2 had not been used in three weeks and could not be flushed prior to sampling because the well house was filled with water up to the level of the spigot. Consequently the water sample from this well appeared cloudy. The field sampling data for the offsite groundwater sampling program can be found in Appendix H and the analytical results are presented in Tables 4-10 and 4-11.

In 1978 the Region IV U.S. EPA, Enforcement Division tasked the Region IV, Surveillance and Analysis Division (SAD) to collect water samples from residential wells in Riverside Gardens. In November 1978, SAD collected samples from eleven residential wells and in December 1978, SAD resampled five of the residential wells. Two of these wells were again resampled in December, 1984 during the RI. The other nine wells originally sampled in 1978 were no longer in use in 1984. Section 2.4 of this report contains a discussion of the private well inventory conducted by Ecology and Environment. Three residential wells, which had not been sampled previously, were sampled during the RI. Several other residents were contacted but no longer used their wells because the city of Louisville

TABLE 4-10
SUMMARY OF INORGANIC ANALYTICAL RESULTS OF GROUNDWATER SAMPLES
PRIVATE WELLS - BOTTOM OF AQUIFER
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Parameter in ug/l	Upgradient Monitor Well MW-2		Borden Well NE of Fill BW-1	LG & E Well SW of Fill LW-2	Indiana Private Water Supply Wells Across Ohio River IN-2	IN-1	
	12/84	1/85	12/84	12/84	12/84	12/84	1/85
Inorganics							
Silver	-	-	15	12	-	-	-
Barium	58	71	62	-	-	50	52
Chromium	120	57J	-	-	-	12	R
Copper	91	43	-	-	33	46	11
Nickel	66	37	-	-	-	-	-
Lead	28	23J	-	-	10	-	2.8J
Zinc	100	130	13	33	320	34	19J
Aluminum	540	260	-	-	240	100	-
Manganese	93	230J	260	610	370	320	350J
Calcium	25,000	50,000	89,000	210,000	100,000	93,000	89,000
Magnesium	8,600	14,000	32,000	17,000	29,000	28,000	26,000
Iron	2,400	1,900	1,300	800	8,900	300	150J
Sodium	38,000	24,000J	21,000	31,000	8,400	17,000	35,000J
Cyanide	-	-	-	-	20J	20J	-
Potassium	61,000	27,000	1,500	10,000	1,200	1,200	1,600
Bicarbonate (as HCO_3 ion)	180,000	NA	170,000	28,000	170,000	180,000	NA
Carbonate (as CO_3 ion)	59,000	NA	-	-	-	-	NA
Chloride	28,000	NA	22,000	29,000	9,000	23,000	NA
Sulfate	89,000	NA	86,000	630,000	59,000	61,000	NA

- Not detected.
J Estimated value.
R Quality control indicates data are unuseable.
NA Not analyzed.

LEE 001 000932

LEE 001 000933

TABLE 4-11
SUMMARY OF ORGANIC ANALYTICAL RESULTS OF GROUNDWATER SAMPLES
PRIVATE WELLS - BOTTOM OF AQUIFER
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Parameter in ug/l	Upgradient Monitor Well MW-2 12/84	Upgradient Monitor Well MW-2 1/85	Borden Well NE of Fill BW-1 12/84	LG & E Well SW of Fill LW-2 12/84	Indiana Private Water Supply Wells Across Ohio River IN-2 12/84	Indiana Private Water Supply Wells Across Ohio River IN-1 12/84	Indiana Private Water Supply Wells Across Ohio River IN-1 1/85
Extractable Organics							
Bis (2-Ethylhexyl) Phthalate	20J	-	6J	-	-	-	-
Phenol	300J	76	-	R	-	-	-
4-Methylphenol	-	2J	-	R	-	-	-
Ethylhexanoic Acid	10JN	-	-	-	-	-	-
Unidentified Compounds	-	-	3-20J	2-10J	1-9J	-	-
Purgeable Organics							
Chloroform	5J		-	-	-	-	-
Benzene	-	20	-	-	-	-	-
Toluene	10J	-	-	-	-	-	-
Propanol	100JN	-	-	-	-	-	-
Ethanol	10JN	-	-	-	-	-	-
Carbon Disulfide	-	13	-	-	-	-	-
2-Propanol	-	-	-	-	9,000JN	-	-
Diethylether	-	-	-	-	-	-	40JN
Unidentified Compound	-	-	-	-	-	-	1-500J

J Estimated value.
\- Not detected.
R Quality control indicates data are unuseable.
N Presumptive evidence of presence of material.

currently supplies drinking water to the majority of Riverside Garden residents. Only eight residential wells have been identified by the owners as being a drinking water supply. The other two wells sampled during the RI were used for gardening and watering lawns. The analytical results were used to determine if contaminated groundwater exists in the alluvial aquifer beneath Riverside Gardens and to evaluate the potential for contaminated groundwater migration in the direction of the residential neighborhood.

The samples from the five residential wells in Riverside Gardens were collected directly into the sample containers from either a spigot or from a hand pump. In each case the well was flushed of standing water until a stable specific conductivity was reached before sampling. The field sampling data can be found in Appendix H and the analytical results from the 1978 and 1984 sampling are presented in Tables 4-12 through 4-15.

4.5 Groundwater Characterization

The groundwater characterization for the Lees Lane Landfill Site consisted of five activities. The contaminants in the groundwater at the site were quantified through a sampling and analysis program and the results of this activity were presented in the previous section. The contaminants identified through sampling and analysis were further evaluted to determine the contaminants of interest based on both the concentrations and sample locations. The distribution of these contaminants of interest was then evaluated to investigate potential current leachate production rates by tract and over time. The distribution was also employed in the evaluation of offsite effects. The groundwater flow patterns at the time of sample collection were used to predict potential migration pathways and the concentrations of contaminants found in drinking water supplies were examined to determine potential public health effects.

4.5.1 Contaminants of Interest

The contaminants of interest have been identified through a detailed evaluation of all organic and inorganic constituents found in the groundwater at the site during the Remedial Investigation. Data collected during previous investigations have not

TABLE 4-12
SUMMARY OF ANALYTICAL RESULTS OF GROUNDWATER SAMPLES
RESIDENTIAL WELLS - LANDFILL BOUNDARY TO HOWARD AVENUE
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

	Simpson Well HO-508			Downs Well WM-422	
Parameter in ug/l	11/78	12/78	12/84	11/78	12/78
Inorganics					
Silver	<10	<10	9.4	<10	<10
Arsenic	<25	<25	-	<25	<25
Beryllium	<10	<10	-	<10	<10
Cadmium	<10	<10	-	<10	<10
Chromium	<10	<10	-	<10	<10
Copper	<10	<10	-	12	10
Nickel	<20	<20	-	<20	<20
Lead	<25	<25	12	31	<25
Antimony	<25	<25	-	<25	<25
Selenium	<25	<25	-	<25	<25
Strontium	110	108	NA	134	123
Zinc	3,090	3,595	3,200	881	1,128
Manganese	NA	NA	11	NA	NA
Calcium	95,000	92,000	92,000	108,000	100,000
Magnesium	33,000	32,000	32,000	38,000	35,000
Iron	<100	<100	160	<100	200
Sodium	NA	NA	26,000	NA	NA
Potassium	NA	NA	1,500	NA	NA
Bicarbonate (as HCO_3 ion)	NA	NA	160,000	NA	NA
Carbonate (as CO_3 ion)	NA	NA	2,000	NA	NA
Chloride	NA	NA	26,000	NA	NA
Sulfate	NA	NA	98,000	NA	NA
Organics					
None Detected					

- Not detected.
NA Not analyzed.

LEE 001

000936

TABLE 4-13
SUMMARY OF ANALYTICAL RESULTS OF GROUNDWATER SAMPLES
RESIDENTIAL WELLS - HOWARD AVENUE TO PUTNAM STREET
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

	Faircloth Well LE-416		Frankie Well/Geary Well WL-416		Ashley Well WM-408	
Parameter in ug/l	11/78	12/84	11/78	12/84	11/78	12/78
Inorganics						
Silver	<10	-	<10	11	<10	<10
Arsenic	<25	-	<25	-	<25	<25
Beryllium	<10	-	<10	-	<10	<10
Cadmium	<10	-	<10	-	<10	<10
Chromium	<10	-	<10	-	<10	<10
Copper	18	-	144	-	18	<10
Nickel	<20	-	<20	-	<20	<20
Lead	<25	-	121	15	<30	<25
Antimony	<25	-	<25	-	<25	<25
Selenium	<25	-	<25	-	<25	<25
Strontium	103	NA	148	NA	164	195
Zinc	309	240	3,486	1,100	602	903
Calcium	90,000	92,000	124,000	92,000	129,000	147,000
Magnesium	32,000	33,000	41,000	33,000	44,000	52,000
Iron	<100	100	6,800	1,300	100	<100
Sodium	NA	24,000	NA	25,000	NA	NA
Potassium	NA	1,600	NA	1,600	NA	NA
Bicarbonate (as HCO_3 ion)	NA	180,000	NA	180,000	NA	NA
Chloride	NA	25,000	NA	27,000	NA	NA
Sulfate	NA	88,000	NA	90,000	NA	NA
Extractable Organics						
Bis (2-Ethylhexyl) Phthalate	-	2	-	2	-	-

\- Not detected
NA Not analyzed

LEE 001

000937

TABLE 4-14
SUMMARY OF ANALYTICAL RESULTS OF GROUNDWATER SAMPLES
RESIDENTIAL WELLS - PUTNAM STREET TO MELROSE STREET
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Parameter in ug/l	Williamson Well ME-618	Wright Well ME-616		Wright Well PU-519	Hayburn Well PU-503		Parker Well LE-405
	12/84	11/78	12/78	11/78	11/78	12/78	11/78
Inorganics							
Silver	13	< 10	< 10	< 20	< 10	< 10	< 10
Arsenic	-	< 25	< 25	< 25	< 25	< 25	< 25
Beryllium	-	< 10	< 10	< 10	< 10	< 10	< 10
Cadmium	-	< 10	< 10	< 20	< 10	< 10	< 10
Chromium	-	< 10	< 10	28	< 10	< 10	< 10
Copper	68	20	14	25,570	16	13	13
Nickel	-	< 20	< 20	< 40	< 20	< 20	< 20
Lead	32	< 25	< 25	1,144	< 30	< 25	< 25
Antimony	-	< 25	< 25	< 40	< 25	< 25	< 25
Selenium	-	< 25	< 25	< 25	< 25	< 25	< 25
Strontium	NA	115	118	510	105	105	104
Zinc	2,900	2,067	2,108	31,880	769	789	828
Manganese	22	NA	NA	NA	NA	NA	NA
Calcium	82,000	98,000	100,000	100,000	91,000	90,000	90,000
Magnesium	30,000	35,000	36,000	35,000	33,000	32,000	32,000
Iron	9,200	<100	< 100	133,000	< 100	<100	<100
Sodium	27,000	NA	NA	NA	NA	NA	NA
Potassium	1,900	NA	NA	NA	NA	NA	NA
Bicarbonate (as HCO_3 ion)		160,000	NA	NA	NA	NA	NA
Chloride	28,000	NA	NA	NA	NA	NA	NA
Sulfate	90,000	NA	NA	NA	NA	NA	NA
Purgeable Organics							
2-Propanol	10JN	-	-	-	-	-	-

- Not detected
NA Not analyzed
J Estimated value
N Presumptive evidence of presence of material

LEE 001

000938

TABLE 4-15
SUMMARY OF ANALYTICAL RESULTS OF GROUNDWATER SAMPLES
RESIDENTIAL WELLS - MELROSE STREET TO LUCERNE STREET
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Parameter in ug/l	Salleng Well LU-614 11/78	Mann Well LU-604 11/78	Church Well RBW-1 12/84
Inorganics			
Silver	10	10	-
Arsenic	<25	<25	-
Beryllium	<10	<10	-
Cadmium	<10	<10	-
Chromium	<10	<10	-
Copper	13	14	39
Nickel	<20	<20	-
Lead	<25	31	5.4
Antimony	<25	<25	-
Selenium	<25	<25	-
Strontium	121	110	NA
Zinc	343	3,992	1,900
Aluminum	NA	NA	97
Manganese	NA	NA	400
Calcium	100,000	95,000	94,000
Magnesium	36,000	34,000	32,000
Iron	<100	<100	100
Sodium	NA	NA	23,000
Potassium	NA	NA	1,900
Bicarbonate (as HCO_3 ion)	NA	NA	160,000
Chloride	NA	NA	23,000
Sulfate	NA	NA	86,000

Organics

None Detected

- Not detected.
NA Not analyzed.

been included in the identification of contaminants of interest since these data are not considered representative of current site conditions. In an effort to provide the most comprehensive evaluation possible, all groundwater samples collected during the Remedial Investigation were included.

The evaluation of the groundwater analytical data was based on an initial screening of both organic and inorganic constituents. Each identified constituent was then further evaluated to determine if the constituent could be considered characteristic of leachate produced by the landfill. Finally, the remaining constituents were evaluated to determine if the concentrations identified, in relation to the location of the sampling points, indicated that the constituent should be considered a contaminant of interest.

The resulting contaminants of interest will be applied to the evaluations performed on other media at the site. These constituents are not necessarily considered contaminants of concern since the concentrations found may not be excessive. The public health concerns related to the contaminants of concern are discussed in Section 8.0.

4.5.1.1 Organic Constituents

A careful examination of all the organic analytical results presented in Section 4.4 reveals only one organic parameter of interest, benzene. (For reference, each organic parameter and the associated concentrations found in groundwater samples analyzed as part of the Remedial Investigation has been tabulated and can be found in Section 8.2.4.) Benzene was detected in only two samples. The first was collected from the shallow groundwater as it entered the Ohio River in the central tract (WP-3 at 450 ug/l) and the second was collected from the upgradient monitor well screened at the bottom of the aquifer (MW-02 at 20 ug/l). Evaluation of the analytical results of groundwater samples collected near the two samples containing benzene reveals that neither sample appears to be representative.

In the case of the downgradient sample (WP-3), there were three nearby samples collected and benzene was not detected in any of them. The first of these samples was from a monitor well screened in the bottom of the aquifer (MW-04). The second was from a monitor well screened in the fill (LL-11) and directly upgradient of the shallow groundwater sample. The third was a second nearby shallow groundwater sample (WP-4) collected in the same manner as the one containing benzene. In the case of the upgradient sample containing benzene, the same sampling point (MW-02) was sampled twice during the remedial investigation. The first sample was collected in December of 1984 and contained no benzene above the detection limits. The second sample, collected one month later, contained 20 ug/l of benzene. Therefore, it is reasonable to presume that the two instances of benzene concentrations identified in the groundwater samples are not representative of the groundwater at the site.

The public health effects of benzene will be examined in Section 8.0 but it will not be considered a contaminant of interest in terms of the groundwater characterization.

4.5.1.2 Inorganic Constituents

A similar compilation of the inorganic parameters detected in the groundwater at the site is presented in Table 4-16. The presence of inorganic constituents in groundwater is considered characteristic of landfill leachate production and metals and other inorganic contaminants have been historically associated with groundwater and leachate analyses performed at the site. The table includes the maximum concentration detected in any groundwater sample and the Maximum Contaminant Levels (MCLs) set in the National Interim Primary or Secondary Drinking Water Regulations. The MCLs have been used for comparison purposes only and are not directly applicable to any of the samples collected. (The MCLs are intended only for application at the point of use as public drinking water and as such should not be applied to the residential wells in Riverside Gardens since these are private supplies. These MCLs are not even applicable to the public water supply well samples collected from the Edwardsville Water Company well field since this water was sampled prior to distribution.) Use of the MCLs for comparison is conservative but considered appropriate since the groundwater at the site may potentially migrate to either the nearby residential or public water supply wells.

TABLE 4-16
INORGANIC CONSTITUENTS FOUND IN GROUNDWATER
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Parameter	Max. Concentration Detected (ug/l)	MCL (ug/l)*
Silver	15	NIPDWR-50
Arsenic	**87**	**NIPDWR-50**
Barium	**1,100**	**NIPDWR-1,000**
Cadmium	**22**	**NIPDWR-10**
Cobalt	160	
Chromium	**640**	**NIPDWR-50**
Copper	220	NSDWR-1,000
Nickel	340	
Lead	**150**	**NIPDWR-50**
Vanadium	270	
Zinc	3,200	NSDWR-5,000
Aluminum	17,000	
Manganese	**44,000**	**NSDWR-50**
Calcium	350,000	
Magnesium	150,000	
Iron	**190,000**	**NSDWR-300**
Sodium	63,000	
Cyanide	0.020J	
Potassium	61,000	
Chloride	63,000	NSDWR-250,000
Sulfate	**630,000**	**NSDWR-250,000**

* MCLS are indicated as
NIPDWR - National Interim Primary Drinking Water Regulations
NSDWR - National Secondary Drinking Water Regulations

Eight inorganic constituents were found in groundwater at the site in concentrations above the MCLs. These eight constituents were evaluated as potential contaminants of interest. Table 4-17 lists each constituent, the National Interim Primary or Secondary Drinking Water MCL, the concentrations found above the MCL and the associated sample locations within the alluvial aquifer. In some instances the constituent was not detected in any of the samples collected and in two instances sulfate was not included in the analyses performed. Where all analyses performed were below the MCL it was so indicated on the table. Where only one sample was above the MCL the location of the sampling point was included for reference. Where multiple samples were above the MCL the range of concentrations found were shown. Since two samples were collected from the upgradient monitor well, in the lower portion of the aquifer, both concentrations were indicated. For the downgradient wells set above bedrock, both sets of analyses were treated equally.

The upper portion of the alluvial aquifer was evaluated first. The samples collected from the temporary well points located approximately ten feet below the ground surface and set a few feet into the water table were considered representative of the shallow groundwater being released to the Ohio River. These samples can not be considered characteristic of the overall shallow groundwater since the samples were collected from a single-point-in-time and only from the upper few feet of the aquifer. However, these samples are indicative of the presence or probable absence of contaminants. Since barium, cadmium, and chromium were detected at concentrations below the MCLs in all six samples, it is probable that these constituents are not present in shallow groundwater being discharged to the Ohio River in concentrations high enough to suggest contamination. Although sulfate analyses were not performed on the shallow groundwater samples collected from the temporary well points, the three samples collected from the shallow monitor wells located onsite did not contain concentrations of sulfate above the MCLs. Therefore, it is also reasonable to presume that sulfate is probably not present in shallow groundwater being discharged to the Ohio River in concentrations high enough to suggest contamination. The remaining constituents, arsenic, lead, manganese, and iron will be considered further.

LEE 001 0009413

TABLE 4-17
SUMMARY OF THE INORGANIC CONSTITUENTS IN GROUNDWATER FOUND IN EXCESS OF THE MAXIMUM CONTAMINANT LEVELS
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

		Upper Portion of Alluvial Aquifer				Lower Portion of Alluvial Aquifer		
Parameter in ug/l	Primary Drinking Water MCL	Upgradient Monitor Well	Residential Wells	Downgradient Monitor Wells	Downgradient Well Points	Upgradient Monitor Well	Downgradient Monitor Wells	Private Wells
Arsenic	50	-	-	LL-9/87	WP-3/60J	-	Below MCL	-
Barium	1,000	56	-	Below MCL	Below MCL	58/71**	MW-5/1,100	Below MCL
Cadmium	10	-	-	LL-9/22	Below MCL	-	-	-
Chromium	50	43	-	LL-9/140	Below MCL	120/57J**	30J-640	Below MCL
Lead	50	7.2	Below MCL	LL-9/150	WP-1/83	28/23J**	MW-3/68J	Below MCL
Manganese	50*	300	0-400	2,200-7,900	940-5,100	93/230J**	420J-44,000	260-610
Iron	300*	5,200	100-9,200	3,700-190,000	25,000-60,000	2,400/1,900**	4,200-17,000	150J-8,900
Sulfate	250,000*	91,000	Below MCL	Below MCL	NA	8,900/NA**	Below MCL	LW-2/630,000

* Secondary Drinking Water MCL.
** Sample from Dec. 84/Jan. 85.
\- Not detected.
J Estimated value.
NA Not analyzed.

The evaluation of the lower portion of the alluvial aquifer was performed in a slightly different manner. The initial evaluation of the groundwater above the shale bedrock was centered on the groundwater samples collected from the monitor wells installed during the Remedial Investigation. Each of these three wells was sampled twice, one month apart. The analyses, again, can not be considered characteristic since the period of sampling was not representative of the seasonal variations in groundwater quality. However, the ranges of concentrations found is indicative of the presence or probable absence of contaminants.

Arsenic, cadmium, and sulfate were found in the downgradient monitor wells at concentrations below the MCLs or were not identified above the detection limits. Only barium, chromium, lead, manganese, and iron will be retained for further evaluation.

Table 4-18 presents the four constituents being further evaluated for the upper portion of the alluvial aquifer and a comparison of the concentrations found in the shallow well points to those found immediately adjacent to them a few feet off-shore in the Ohio River. (The Ohio River sample results are discussed and presented in Section 5.4.3.) Neither arsenic nor lead were identified above the detection limits in the Ohio River samples, but WP-3 and WP-4 located in the Central Tract both contained measurable levels of arsenic. Lead will not be considered further.

Based on the above evaluation, arsenic, manganese, and iron will be considered contaminants of interest for the upper portion of the alluvial aquifer and barium, chromium, lead, manganese, and iron will be considered contaminants of interest for the lower portion. Since the constituents are all metals, the upper portion of the aquifer is expected to be the source of contaminants to the lower portion. Therefore, the distribution of all six contaminants of interest will be discussed for both portions of the aquifer.

4.5.2 Distribution of Contaminants

The production of leachate by landfills is usually related to the wastes within the landfill, the age and state of decomposition of these wastes, and the quantity of water available. Since the landfill history suggests widely varying wastes and disposal periods, an evaluation of the potential differences in current leachate production rates or quality was performed. The samples collected from the shallow well points located along the Ohio River bank were reasonably well-distributed and were intended to intercept the leachate stream, if one existed. These samples were collected in November during the lowest groundwater levels at the site during the Remedial Investigation and may not be characteristic of leachate production. However, these samples are appropriate for comparison from tract to tract since they were all collected under the same conditions. This comparison is presented in Table 4-19. Since the range of concentration shown is so similar, no conclusions can be drawn in terms of current leachate production rates by tract.

A similar comparison of the six contaminants of interest was made for the shallow groundwater monitor well samples collected in 1981 by EPA to those collected during the Remedial Investigation. It must be understood that these data may not be directly comparable. The 1981 samples were collected in April and the 1984 samples were collected in December during a different portion of the groundwater year. Additionally, the Kentucky NREPC monitor well in the Northern Tract could not be found during the Remedial Investigation and could not be resampled. The sample results discussed above are presented in Table 4-20. An examination of the concentrations shown for the Central and Southern Tracts (LL-11 and LL-9, respectively) suggests an overall reduction in concentrations of a magnitude that may well be indicative of reduction in concentration although the absolute values must be questioned.

To further explore the variable nature of groundwater at the site, the two sets of samples, collected under the same conditions during the Remedial Investigation but one month apart, (during reasonably low stages on the Ohio River in December and January), were compared in Table 4-21. These samples were collected from the monitor wells installed above the shale bedrock and represent groundwater quality in the lower portion of the aquifer. Since the samples were collected only one month apart, the ranges in concentration shown are not characteristic of groundwater quality at the site but are probably indicative of the typical variation in groundwater quality. An examination of the table suggests that the

TABLE 4-19
COMPARISON BY TRACT OF SELECTED CONSTITUENTS
SHALLOW GROUNDWATER AT OHIO RIVER
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Parameter in ug/l	Upgradient Monitor Well MW-01	Northern Tract WP-1/WP-2	Central Tract WP-3/WP-4	Southern Tract WP-5/WP-6
Arsenic	-	-/50J	60J/20J	-/-
Barium	56	210/400	470/400	390/220
Chromium	43	29/-	0/29	22/33
Lead	7.2	83/23	21/17	20/18
Manganese	300	1,400/1,700	1,300/2,200	5,100/940
Iron	5,200	25,000/47,000	60,000/57,000	40,000/34,000

- Not Detected

J Estimated Value

TABLE 4-20
COMPARISON BY TIME OF SELECTED CONSTITUENTS
UPPER PORTION OF THE ALLUVIAL AQUIFER
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

LEE 001
000947

	Northern Tract		Central Tract		Southern Tract	
Parameter in ug/l	LL-1 1981	WP-1/WP-2 1984	LL-11 1981	LL-11 1984	LL-9 1981	LL-9 1984
Arsenic	-	-/50J	120	10	700	87
Barium	360	210/400	1,340	270	4,850	880
Chromium	40	29/-	180	19	900	140
Lead	40	83/23	160	47	-	150
Manganese	1,910	1,400/1,700	16,800	7,300	37,600	7,900
Iron	25,800	25,000/47,000	297,000	32,000	1,750,000	190,000

- Not Detected

J Estimated Value

000948
LEE 001

TABLE 4-21
COMPARISON BY TIME OF SELECTED CONSTITUENTS
LOWER PORTION OF THE ALLUVIAL AQUIFER
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Parameter in ug/l	Upgradient MW-2		Northern Tract MW-3		Central Tract MW-4		Southern Tract MW-5	
	12/84	1/85	12/84	1/85	12/84	1/85	12/84	1/85
Arsenic	-	-	-	4.3	-	7.3	-	8.1
Barium	58	71	81	130	180	210	1,100	790
Chromium	120	57J	640	210	230	30J	360	400
Lead	28	23J	20	68J	15	17J	11	44J
Manganese	93	230J	740	420J	830	900J	44,000	3,400J
Iron	2,400	1,900	9,100	6,000	11,000	17,000	4,200	11,000

- Not detected.

J Estimated value.

concentration of each contaminant of interest can be expected to vary widely from month to month and an order of magnitude of change is demonstrated by manganese in the Southern Tract.

The distribution of contaminants offsite was also investigated to the extent possible. The offsite data available for the upper portion of the alluvial aquifer includes that collected from the Ohio River downgradient of the site and that collected from the residential wells in Riverside Gardens potentially upgradient of the site. The offsite data available from the lower portion of the aquifer includes that collected from the public water supply wells in Indiana as well as the industrial private wells located downgradient of the site. Table 4-22 provides the comparison of these data. As can be seen from the table, barium, chromium, and lead in all offsite samples are below the appropriate upgradient groundwater concentrations. Arsenic was not detected in any offsite samples. The presence of manganese and iron in higher concentrations in the offsite wells than in appropriate upgradient monitor wells was carefully evaluated to determine the potential site contributions.

The residential wells were examined first. The only well containing manganese concentrations above the upgradient well concentration was RBW-1, located a block from the upgradient well. Due to its location, the concentration of manganese found is unlikely to be related to the site. Only one well (ME-618) contained iron concentrations above those in the upgradient well. Another well located much closer to the site (HO-508) contained very low concentrations of iron and therefore the iron is not likely to be related to the site.

In the case of the industrial wells and the public water supply wells in Indiana, the source of the manganese and iron, respectively, can not be determined from the distribution of contaminants.

4.5.3 Migration Pathways

Water level measurements were made in the monitor wells at the time of sample collection. Access to the private wells for water level measurement was not

TABLE 4-22
COMPARISON BY PORTION OF AQUIFER OF SELECTED CONSTITUENTS
OFFSITE WATER SAMPLES
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

LEE 001 0009550

Parameter in ug/l	Upper Portion of the Alluvial Aquifer			Lower Portion of the Alluvial Aquifer		
	Upgradient Monitor Well	Upgradient Residential Wells	Downgradient Ohio River	Upgradient Monitor Well	Downgradient Industrial Wells	Downgradient Ind. PWS Wells
Arsenic	-	-	-	-	-	-
Barium	56	-	-	58-71	0-62	0-52
Chromium	43	-	-	57J-120	-	0-12
Lead	7.2	0-32	-	23J-28	-	0-10
Manganese	300	0-400	75-120	93-230J	260-610	320-370
Iron	5,200	100-9,200	1,100-1,800	1,900-2,400	800-1,300	150J-8,900

\- Not detected.

J Estimated value.

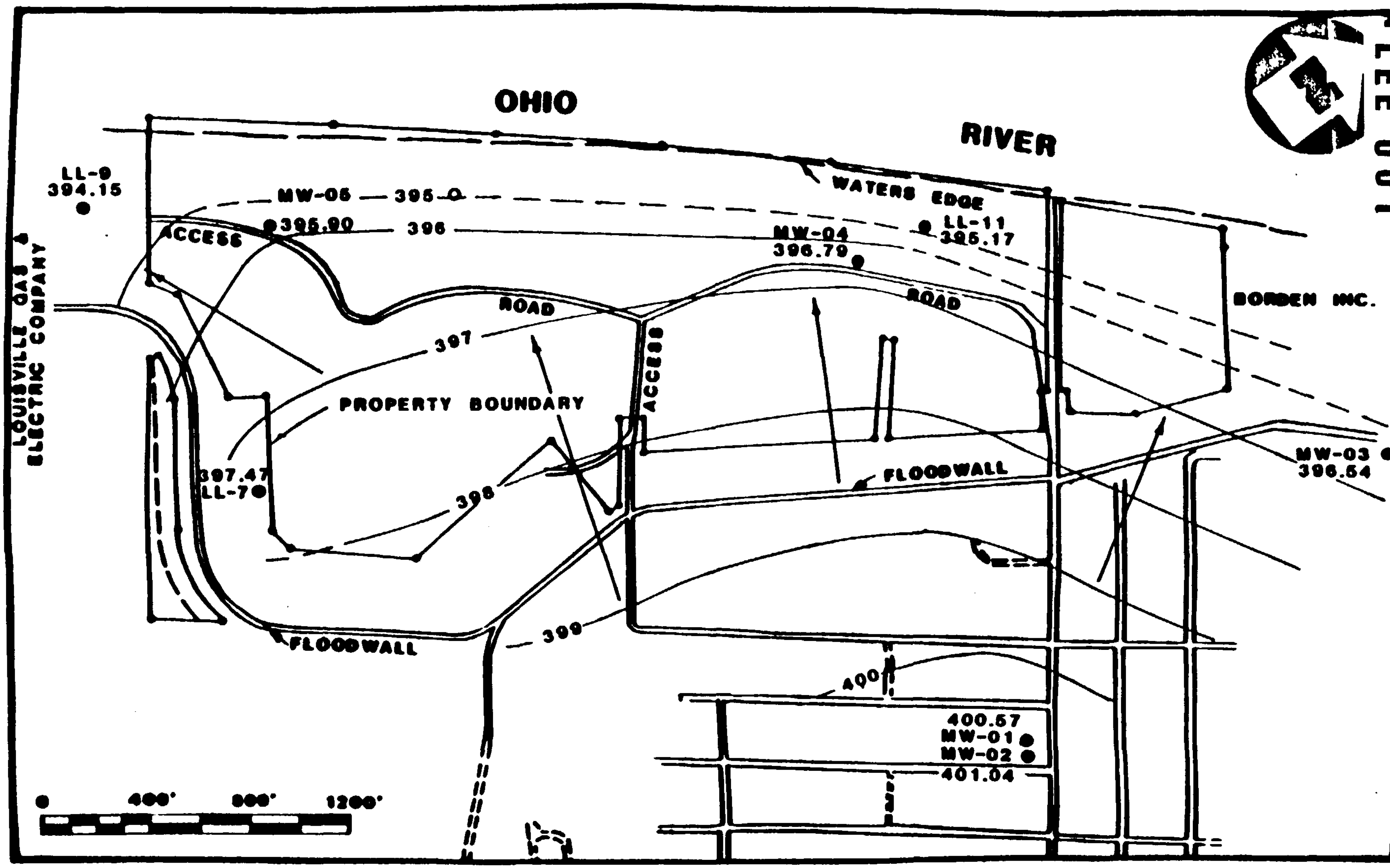
possible. These water levels were plotted and contoured and are presented in Figure 4-16.

The flow pattern at the site suggests that the overall direction of groundwater flow at the time of sampling was toward the Ohio River. However, flow in the Southern Tract may have been toward the Louisville Gas and Electric private well and the concentrations of various parameters shown in Table 4-17 confirms that flow was probably toward LL-9. Flow in the Central and Northern Tracts was toward the Ohio River and therefore the Borden private well was unlikely to be affected by site contaminants at the time of sampling. However, the concentrations shown for MW-03 in Table 4-21 and previous discussions of flow direction suggest that the movement of groundwater may at times be toward MW-03 but the Borden private well is located some distance north of this well and is unlikely to be affected by the site.

If groundwater contaminants are carried below the Ohio River in the lower portions of the alluvial aquifer, the flow at the site during sample collection suggests that these contaminants should be detected in the Edwardsville public water supply wells.

4.5.4 Potential Public Health Effects

Since the potential public health effect associated with groundwater is through ingestion, the results of the analyses performed on the Riverside Gardens residential wells and the Indiana public water supply (PWS) wells were examined in detail. Table 4-23 presents the range of concentrations for each constituent where a National Interim Primary or Secondary Drinking Water MCL exists. Comparison of the analytical data to the MCLs indicates that no sample contained concentrations in excess of the primary drinking water MCLs established to protect public health. Concentrations of manganese and iron in the public water supply wells as well as manganese in the residential wells were found in excess of the secondary drinking water MCLs. These secondary MCLs control contaminants in drinking water that primarily affect the aesthetic qualities relating to the public acceptance.



GROUNDWATER CONTOURS
DECEMBER 4, 5, & 8, 1984
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

FIGURE 4-16

NUS CORPORATION
A Halliburton Company

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LEE 001

000953

TABLE 4-23
COMPARISON OF SELECTED CONSTITUENTS AND MAXIMUM CONTAMINANT LEVELS DRINKING WATER SUPPLIES LEES LANE LANDFILL SITE JEFFERSON COUNTY, KENTUCKY

Parameter (ug/l)	Primary MCL	Secondary MCL	Riverside Gardens Range 12/84	Indiana PWS Range 12/84-1/85
Silver	50		0-9.4	-
Arsenic	50		-	-
Barium	1,000		-	0-52
Cadmium	10		-	-
Chromium	50		-	0-12
Copper		1,000	0-39	11-46
Lead	50		0-12	0-10
Selenium	10		-	-
Zinc		5,000	240-3,200	19J-320
Mercury	2		-	-
Manganese		50	0-400	320-370
Iron		300	100-160	150J-8,900
Chloride		250,000	23,000-26,000	9,000-23,000
Sulfate		250,000	86,000-98,000	59,000-61,000

- Not Detected
J Estimated Quantity
NA Not Analyzed

4.6 Hydrogeologic Summary

The geology encountered at the site consists of unconsolidated Ohio River alluvium and glacial outwash. The unconsolidated material is approximately 110 feet thick and exhibits a fining upward sequence. Directly beneath the unconsolidated material is a shale (New Albany Shale) bedrock reported to be 100 feet thick.

The main hydrogeologic feature at the site is the alluvial aquifer in the unconsolidated sediments. The aquifer is approximately 60 feet thick with the depth to water being 50 feet from ground surface. Permeability values measured during the RI ranged from 2.46×10^{-2} to 8.9×10^{-3} cm/sec. The groundwater flow direction is predominantly toward the Ohio River. An hydraulic connection between the Ohio River and the alluvial aquifer causes a direct response in water levels in the aquifer with river level fluctuations. The flow rate in the aquifer was calculated to be approximately 420 feet/year.

The groundwater quality at the site was found to be good overall. Very few organic compounds were detected and only at low concentrations. The inorganic compounds detected were predominantly metals. Onsite, a few metals were detected at elevated concentrations. Offsite, only iron and manganese were found at elevated levels.

5.0 SURFACE WATER, SEDIMENT AND SOIL INVESTIGATION

The surface investigation performed during the Remedial Investigation of the Lees Lane Landfill Site was designed to determine the presence or probable absence of contaminants on the landfill surface and the potential migration pathways for these contaminants. To accomplish these tasks, a literature review was performed and samples of surface water, sediment, and soil were collected.

5.1 Offsite Surface Water Bodies

The Lees Lane Landfill Site is located near and bordered by two offsite surface water bodies. The largest of these bodies of water is the Ohio River which flows along the western border of the site. The other is Mill Creek Cutoff which flows along the southern border of the site.

5.1.1 Ohio River

The Ohio River Drainage Basin is one of the major drainage basins in the United States, covering 203,900 square miles and including portions of 14 states (Army Corps of Engineers, 1982). From its headwaters in Pittsburgh, Pennsylvania, the Ohio River flows west-southwest 981 miles to its junction with the Mississippi River at Cairo, Illinois. The Lees Lane Landfill Site is located on the Kentucky shoreline southwest of Louisville between Ohio River Mile (RM) 615 and 616. The river and its tributaries are a major source of public drinking water.

5.1.1.1 River Stage and Flow

The Ohio River has been canalized by construction of a series of locks and dams which assure a minimum navigable depth of nine feet. The width between the banks at normal pool level averages about one half mile in the Jefferson County area. The Cannelton Pool adjacent to the site is formed by the Cannelton Dam located at RM 720.7 and the McAlpine Dam located in Louisville at RM 607.3 (see Figure 5-1). The site is located approximately 8 miles downstream of the McAlpine Dam and Locks where there is a gaging station. Since there are no major tributaries between this dam and the Lees Lane Landfill, this gage provides data

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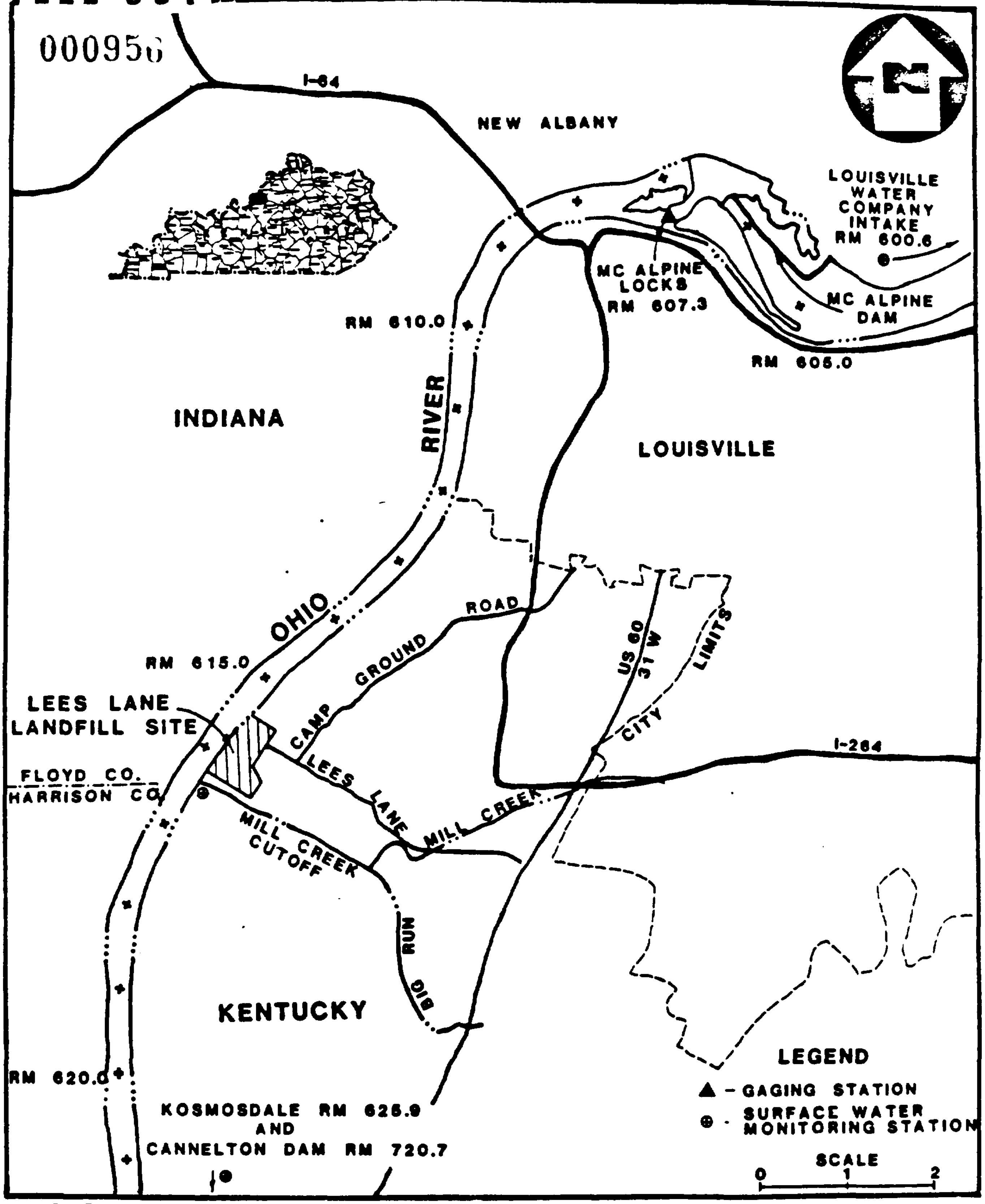

REGIONAL MAP
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

FIGURE 5-1

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indicative of river stage adjacent to the site. The average flow of the Ohio River at Louisville is 114,000 cfs, or 73 billion gallons per day (Bell, 1966). The normal pool elevation is 383.0 feet above mean sea level (amsl), low pool elevation is 374 feet amsl and flood stage is 428.2 feet amsl.

5.1.1.2 Known Dischargers

There are numerous point source dischargers to the Ohio River (see Table 5-1). Primarily, the discharges are concentrated in the Louisville area upstream of the site. Within Kentucky, in addition to obtaining a National Pollutant Discharge Elimination System (NPDES) permit issued by the State of Kentucky, point source dischargers must adhere to the effluent requirements established by the Ohio River Valley Water Sanitation Commission (ORSANCO) and the Division of Water Quality of the Kentucky Natural Resources and Environmental Protection Cabinet (NREPC) (see Appendix I). The standards established by ORSANCO limit discharges of sewage, industrial waste, and cooling water into the Ohio River. The Kentucky Revised Statutes; Chapter 224, grant the Division of Water Quality of the Kentucky NREPC authority to issue its own permit for the discharge of pollutants originating from within the state.

Other significant non-point source discharges to the Cannelton Pool include sewer overflows (combined and private); urban runoff and drainage from agricultural land; and spills and leachates from tank storage facilities and terminals for the loading and unloading of petroleum products, chemicals, coal, grain, and other dry commodities. The extent of the effects of these pollution sources is not known (Army Corps of Engineers, 1982).

5.1.1.3 Water Quality

The water quality of the Ohio River in the Louisville area is monitored at a number of locations by five government agencies: ORSANCO, the U. S. Geological Survey, the States of Kentucky and Indiana, and the EPA. Permanent sampling stations are located at the Louisville Water Company intake at RM 600.6, at Kosmosdale, Kentucky at RM 625.9, and at the Cannelton Dam at RM 720.7. Other water quality data for the Ohio River are available from a monitoring station located at

TABLE 5-1
NPDES FACILITIES ON THE OHIO RIVER IN KENTUCKY
BETWEEN RIVER MILES 600 AND 617

Facility	State	NPDES Permit #	Approximate River Mile
Louisville Water Co. Pump Station - Zorn Avenue	KY	KY0001830	601
Louisville Gas & Electric Gas Turbine - Waterside	KY	KY0002101	602
Chevron USA - Louisville Asphalt Terminal	KY	KY0061395	603
Missouri Portland Cement - Louisville	KY	KY0046027	603
Shell Oil Company - Market Terminal	KY	KY0001104	603
COE McAlpine Lock and Dam (Shop)	KY	KY0020320	606
Ashland Petroleum Company	KY	KY0002291	611
Chevron USA - Louisville Terminal	KY	KY0063002	612
Metropolitan Sewer District (Morris Foreman)	KY	KY0022411	612
American Synthetic Rubber	KY	KY0001589	613
Louisville Gas & Electric - Paddy's Run	KY	KY0002071	613
Rohm and Haas Company	KY	KY0002305	613
Borden Chemical Company	KY	KY0001112	615
Stauffer Chemical Company	KY	KY0002780	615
Louisville Gas & Electric	KY	KY0002062	616

Note: The Lees Lane Landfill Site is located between River Mile 615 and 616.
Source: Kentucky NREPC, Division of Water, 1985.

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the Louisville Gas and Electric Company, Cane Run Plant at RM 616.6. These data, available from the storage and retrieval system (STORET) of the EPA and ORSANCO, summarize the past water quality conditions of the Cannelton Pool upstream and immediately downstream of the Lees Lane Landfill Site (see Table 5-2).

The water in the Ohio River under natural conditions would be slightly hard and of the calcium bicarbonate or calcium magnesium bicarbonate type. However, because of the many industrial dischargers along the River, the basic character of the water has been changed and the hardness has increased over recent years (Bell, 1966). The data in Table 5-2 show that several parameters typically associated with organic waste sources exceed the water quality criteria limits set by ORSANCO and Kentucky. Additionally, other contaminants generally regarded as originating from industrial waste sources have been detected in excessive levels. These include phenol, cyanide, manganese, iron, mercury, sulfate, cadmium, and lead (Army Corps of Engineers, 1982).

5.1.2 Mill Creek Cutoff

From the USGS topographic maps (Lanesville, Ind.-Ky. and Louisville West, Ky.-Ind. quadrangles), it appears that Mill Creek used to flow southwest from Shively and empty into the Ohio River approximately 8.5 miles south of Lees Lane Landfill. Mill Creek Cutoff was apparently constructed to channel water from the upper section of Mill Creek, as well as from Big Run Creek, into the Ohio River just south of the landfill. The Corps of Engineers operates a pump station near the junction of the cutoff and the Ohio River to control the flow of the creek into the river during high flows. Lower Mill Creek is also connected with the cutoff via Garrison Ditch. This lower section of Mill Creek continues flowing southwest into the Ohio River (see Figure 2-1).

Mill Creek Cutoff flows west-northwest into the Ohio River just along the south border of the landfill. Historically, a large portion of the surface runoff from the landfill drained to the south into the cutoff; however, in 1982 completion of the flood protection levee between the site and the creek altered the pathway of overland flow. Mill Creek Cutoff now flows through the levee just before it discharges into the Ohio River. Therefore, the majority of the surface runoff

TABLE 5-2
WATER QUALITY CHARACTERISTICS FOR THE OHIO RIVER
LOUISVILLE WATER COMPANY INTAKE TO THE CANNELTON DAM

Parameter	Unit	Louisville Water Company Intake R.M. 600.6				Cane Run Power Plant R.M. 616.6			
		No. Samples	Min.	Mean	Max.	No. Samples	Min.	Mean	Max.
Water Temperature	°C	65	.2	15.6	31.0	147*	2.0	19.5	23.0
Conductivity	umhos/ml	65	220	342	560	97	255	411	970
Turbidity	JTU	NR	NR	NR	NR	110*	5	33	130
pH	SU	65	7.0	7.4	8.2	97	6.6	7.5	8.3
Hardness (Total)	mg/l	2	140	182	224	97	74	157	530
Suspended Solids	mg/l	63	2	73	539	NR	5	100	444
Dissolved Solids	mg/l	3	17	190	354	NR	NR	NR	NR
Dissolved Oxygen	mg/l	65	4.7	9.4	14.2	147*	1.2	6.8	12.3
Alkalinity (Total)	mg/l	2	84	85	86	97	45	72	105
Ammonia (N)	mg/l	65	0.05	0.18	1.03	97	-	0.31	1.21
Kjeldahl Nitrogen (TKN)	mg/l	65	0.1	0.6	2.1	38*	0.6	1.5	2.9
Nitrite-Nitrate (N)	mg/l	65	0.06	1.09	1.72	97	.03	1.14	3.45
Total Phosphorous (P)	mg/l	65	0.05	0.38	4.37	125*	.08	.22	NR
Silica	mg/l	NR	NR	NR	NR	97	.01	4.3	19.3
Sulfate	mg/l	65	16	85	730	104*	-	88	155
Potassium, dissolved	mg/l	1	NR	3.1	NR	NR	NR	NR	NR
Chloride	mg/l	1	37	37	37	104*	0.2	33	75
Calcium	mg/l	2	34.0	51.5	69.0	97	16.0	40.6	134.3
Magnesium, dissolved	mg/l	NR	NR	NR	NR	45*	8.2	11.2	14.0
Fluoride, dissolved	mg/l	1	NR	.33	NR	72*	.14	.33	.80
Sodium, total	mg/l	25	9.0	18.9	39.0	22	0.8	21.5	72
Phenol	ug/l	62	2	3	15	10*	2	8	31
Cyanide	mg/l	64	0.01	0.01	0.01	8*	.01	.01	.02
BOD_5	mg/l	31	0.0	1.8	4.6	105*	0.1	3.8	12.0
Arsenic, total	ug/l	9	10	10	10	18	<1	1	13
Barium, total	ug/l	25	200	204	300	2*	60	61	62
Cadmium, total	ug/l	26	1	5	5	18	<1	2	8
Chromium, total	ug/l	26	4	28	30	18	<10	19	60
Copper, total	ug/l	27	28	37	90	18	-	19	140
Iron, total	ug/l	27	150	3,490	19,500	18	600	5,630	24,000
Lead, total	ug/l	27	5	15	32	18	<1	32	150
Manganese, total	ug/l	26	30	283	1,190	62	-	562	NR
Mercury, total	ug/l	27	0.1	0.5	0.5	18	<1	<1	3.2
Nickel, total	ug/l	24	20	97	100	18	<10	39	300
Selenium	ug/l	9	5	5	5	18	<10	<10	<10
Silver	ug/l	9	1	27	30	7*	1	3	10
Zinc	ug/l	27	20	59	230	18	-	139	1,150
Total Coliform	No./100 ml	86	120	8,595	130,000	127*	3,400	1,279,025	17,000,000
Fecal Coliform	No./100 ml	86	0	294	3,300	130*	270	79,529	700,000

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TABLE 5-2
WATER QUALITY CHARACTERISTICS FOR THE OHIO RIVER
LOUISVILLE WATER COMPANY INTAKE TO THE CANNELTON DAM
PAGE TWO

		Kosmosdale, KY R.M. 625.9				Cannelton Dam R.M. 720.7			
Parameter	Unit	No. Samples	Min.	Mean	Max.	No. Samples	Min.	Mean	Max.
Conductivity	umhos/ml	64	220	358	575	119	130	363	650
Water Temperature	°C	64	1.0	15.8	31.0	119	-	15.9	30.5
Turbidity	JTU	NR	NR	NR	NR	43	1	50	220
pH	SU	64	6.9	7.3	7.8	119	6.5	7.3	8.4
Hardness (Total)	mg/l	2	141	184	226	54	67	137	190
Suspended Solids	mg/l	61	15	136	1,460	31	5	116	567
Dissolved Solids	mg/l	3	37	196	360	52	103	199	300
Dissolved Oxygen	mg/l	64	4.9	9.2	14.7	67	4.7	9.0	14.0
Alkalinity (Total)	mg/l	2	82	84	85	53	35	63.6	93
Ammonia (N)	mg/l	64	0.05	0.28	0.97	78	-	0.18	1.97
Kjeldahl Nitrogen (TKN)	mg/l	64	0.3	1.0	2.8	114	0.1	0.7	2.5
Nitrite-Nitrate (N)	mg/l	64	.17	1.13	1.75	116	0.02	1.18	2.00
Total Phosphorous (P)	mg/l	64	0.05	0.53	3.04	117	0.03	0.28	2.89
Silica	mg/l	28	1.0	5.0	6.8	51	0.2	4.6	6.6
Sulfate	mg/l	62	42	79	155	119	36	72	156
Potassium, dissolved	mg/l	1	NR	3.0	NR	53	1.8	2.8	3.9
Chloride	mg/l	NR	NR	NR	NR	52	8	22	42
Calcium	mg/l	27	27.0	38.7	47.0	52	19.0	37.6	53.0
Magnesium, dissolved	mg/l	NR	NR	NR	NR	52	4.8	9.8	14.0
Fluoride, dissolved	mg/l	1	NR	.34	NR	53	.10	0.21	.40
Sodium, total	mg/l	24	10.0	19.6	42.0	24	9.0	19.6	37.0
Phenol	ug/l	62	2	3	15	67	2	3	19
Cyanide	mg/l	63	.01	0.01	.01	67	0.01	0.01	0.05
BOD_5	mg/l	31	-	2.5	6.0	32	0.4	2.0	7.4
Arsenic, total	ug/l	9	10	10	10	26	-	5	10
Barium, total	ug/l	25	200	208	300	25	200	200	200
Cadmium, total	ug/l	26	2	5	7	41	-	5	20
Chromium, total	ug/l	25	4	29	30	41	4	23	30
Copper, total	ug/l	27	8	32	100	43	3	26	52
Iron, total	ug/l	27	570	5,515	24,500	43	160	2,586	15,000
Lead, total	ug/l	27	5	22	60	43	-	16	50
Manganese, total	ug/l	26	90	442	1,840	41	20	131	560
Mercury, total	ug/l	26	0.1	0.5	1.0	42	-	0.5	6.0
Nickel, total	ug/l	24	20	97	100	25	20	97	100
Selenium	ug/l	9	5	5	5	16	-	0.25	1.0
Silver	ug/l	9	1	27	30	13	-	19	30
Zinc	ug/l	27	30	128	1,540	43	20	47	120
Total Coliform	No./100 ml	83	1	480,000	6,000,000	86	-	6,934	91,000
Fecal Coliform	No./100 ml	82	1	24,800	99,000	101	-	710	9,400

NR No data reported.
- Not detected.
* Data supplied by the Louisville Gas and Electric Company, Cane Run Plant.

Source: USEPA, STOrage and RETrieval System, excerpted from the Draft Riverport EIS, 1982.

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flowing southward off the landfill is diverted by the levee into the Ohio River before reaching Mill Creek Cutoff. There is still a small section at the mouth of the creek where surface runoff can enter the cutoff, but it will be immediately flushed into the Ohio River.

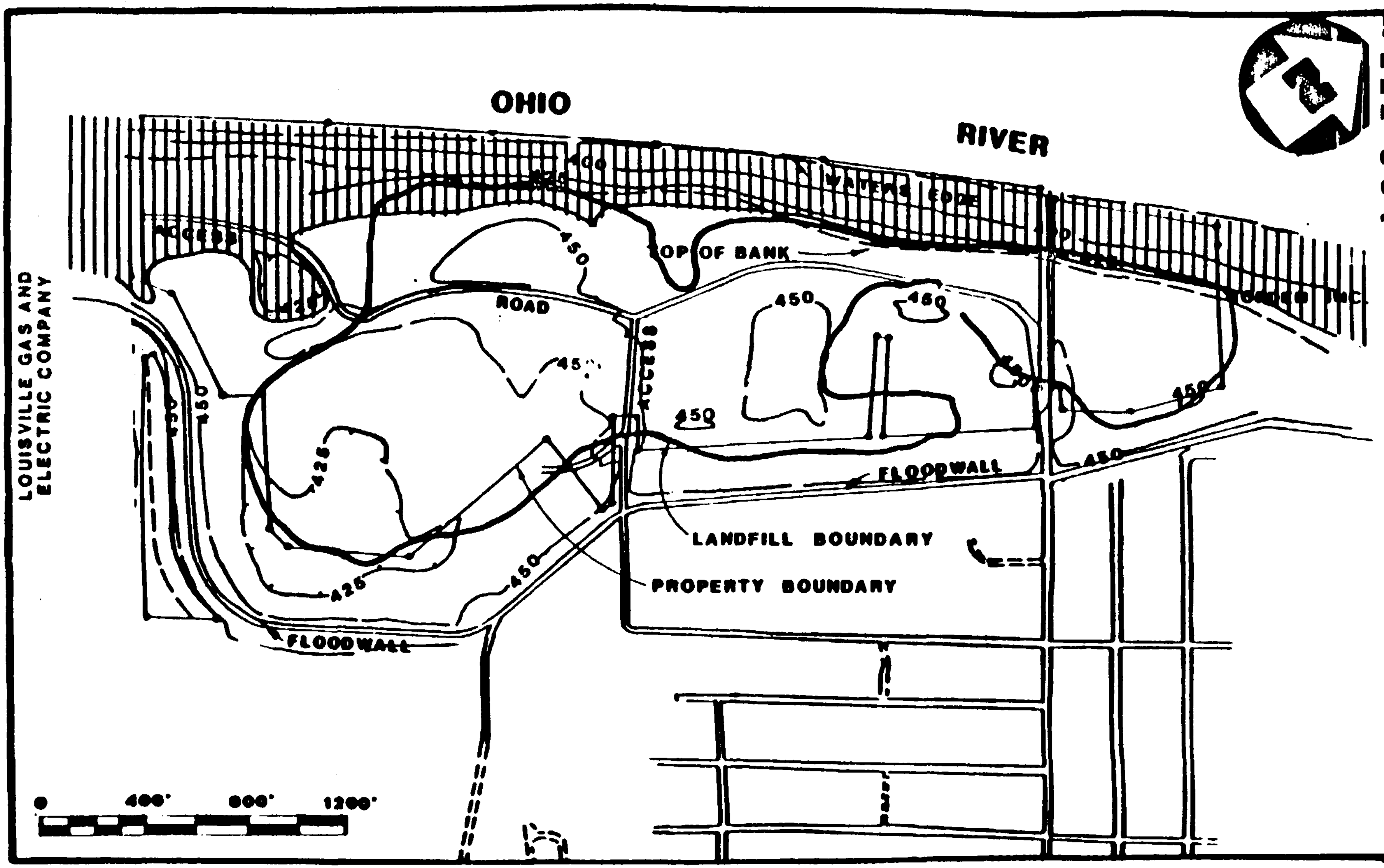
5.1.3 Flood Potential

The Lees Lane Landfill Site lies within the 500-year flood plain of the Ohio River and, therefore, is impacted by the rise and fall of the river. A landfill such as this, without a low-permeability cover and without a structural barrier between the fill and the river, is vulnerable to the erosional forces of the river during high water conditions. Receeding floodwaters present the possibility that sheet and rill erosion will occur, exposing fill material and transporting contaminants into the river. The current condition of the landfill cover and the absence of erosional cuts, however, indicate that this has not been a problem. In addition to potential erosional problems, flooding enhances leachate production and subsequent seepage into the Ohio River. Under these conditions, the dilution factors within the Ohio River are likely to conteract the effects of the increased leachate production rates.

5.1.3.1 Flood Levels and Frequency

The site ranges in elevation from approximately 383 feet amsl at the Ohio River's edge to approximately 461 feet amsl on top of the flood protection levee. The river at flood stage (428.2 feet amsl) would inundate some of the river bank along the landfill (see Figure 5-2). Flood stage is reached with an average frequency of one in 1.2 years and lasts an average of twelve days (Army Corps of Engineers, 1982). The flood season on the Ohio River is between January and April.

The designated 10-year flood level (see Figure 5-3) is 435 feet amsl which would inundate an area approximately 500 feet landward of the river (Ecology and Environment, Inc., 1982). The designated 50-year flood level (see Figure 5-4) is 444 feet amsl which would inundate an area approximately 600 feet from the River (Ecology and Environment, Inc., 1980). The designated 100-year flood level or "Intermediate Regional Flood", such as occurred in 1945, reached a level of 447.6 feet amsl (see Figure 5-5). A flood of this magnitude would cover approximately 25 to 50 percent of the landfill.



FLOOD STAGE ON THE OHIO RIVER
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

FIGURE 5-2

LEGEND

- BOUNDARY OF FILL
- 428.8 FEET MSL

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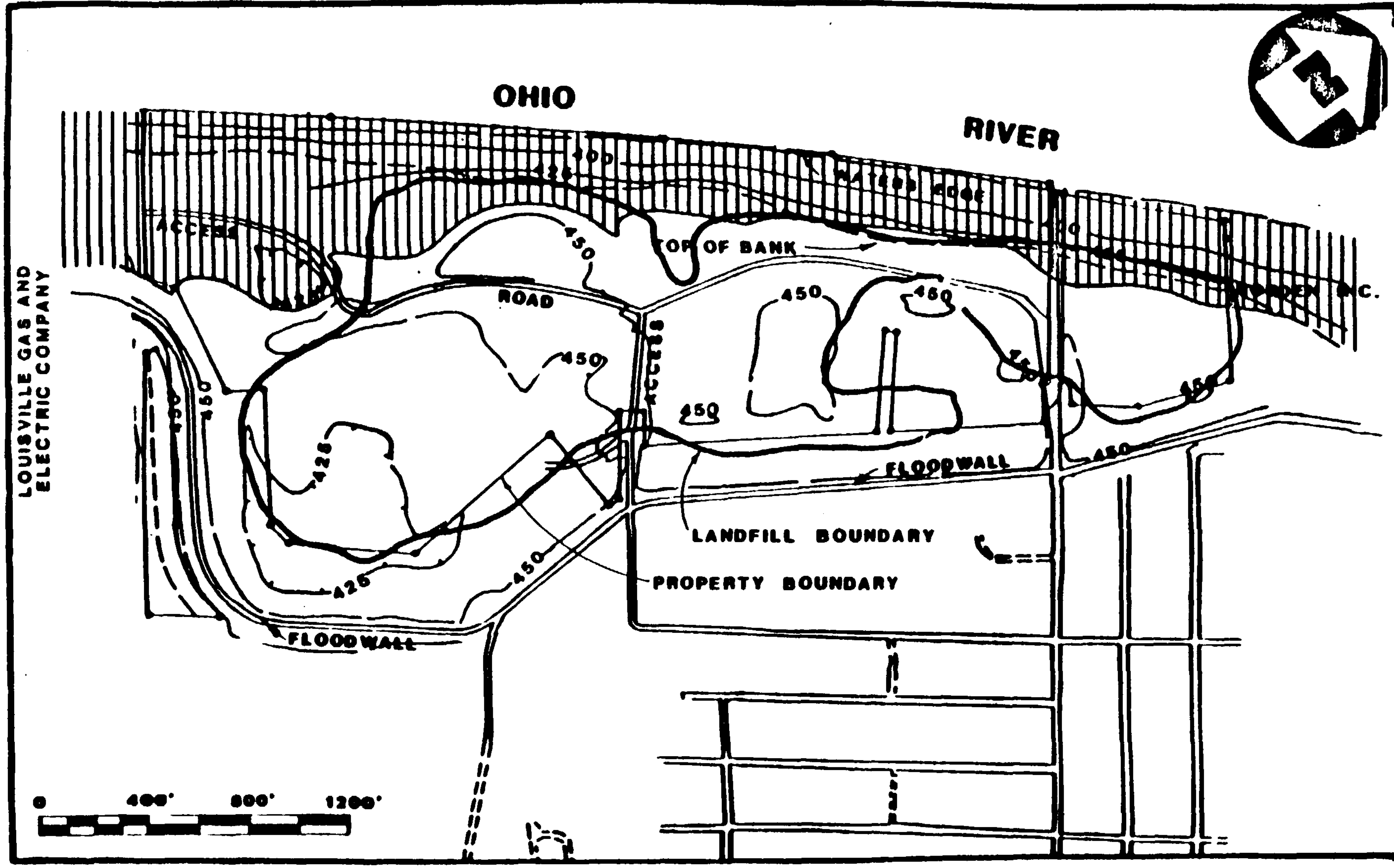

DESIGNATED 10-YEAR FLOOD LEVEL
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

FIGURE 5-3

LEGEND

- BOUNDARY OF FILL
- 435.0 FEET MSL

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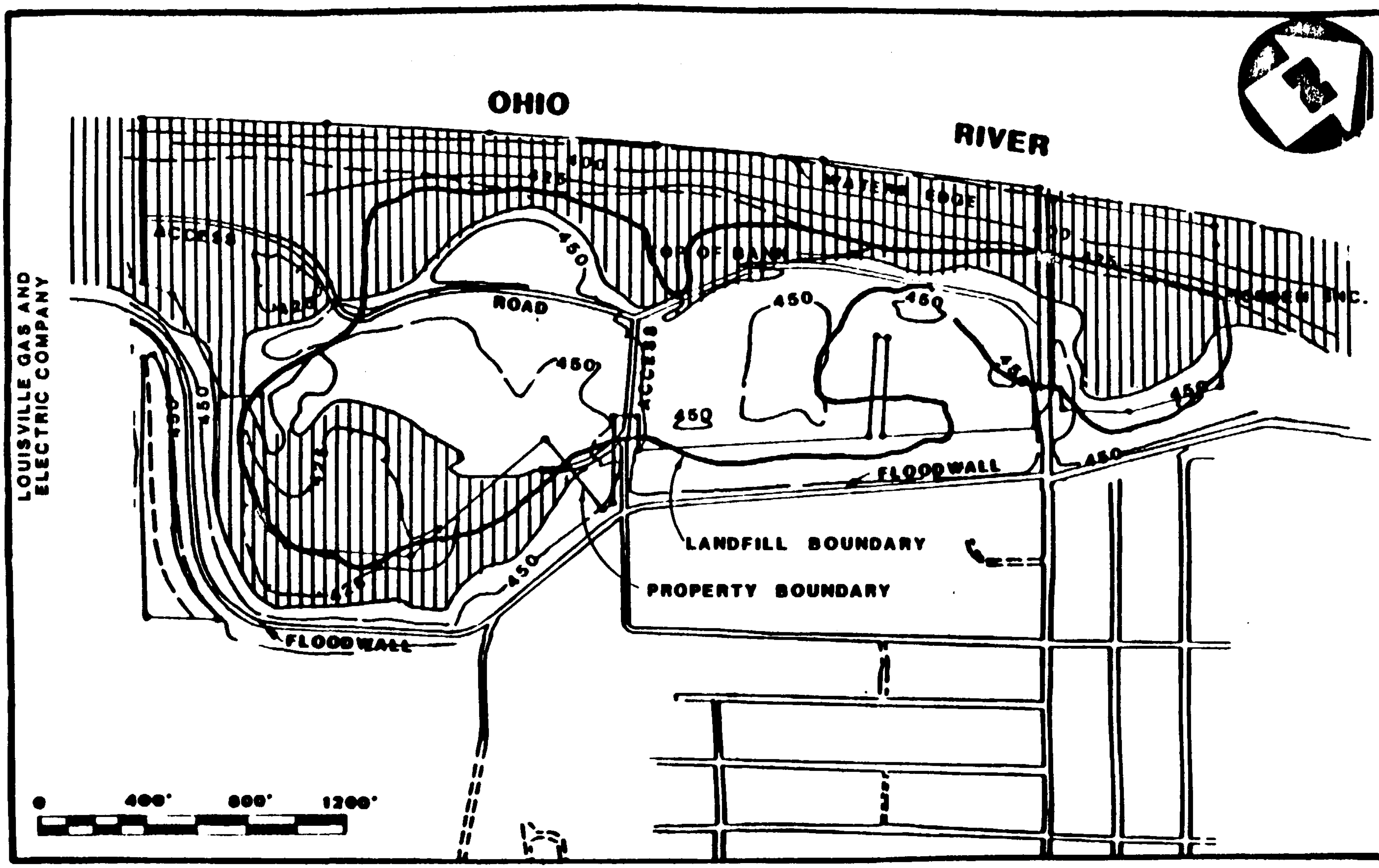

DESIGNATED 50-YEAR FLOOD LEVEL
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

LEGEND

- BOUNDARY OF FILL

- 444.0 FEET MSL

FIGURE 5-4

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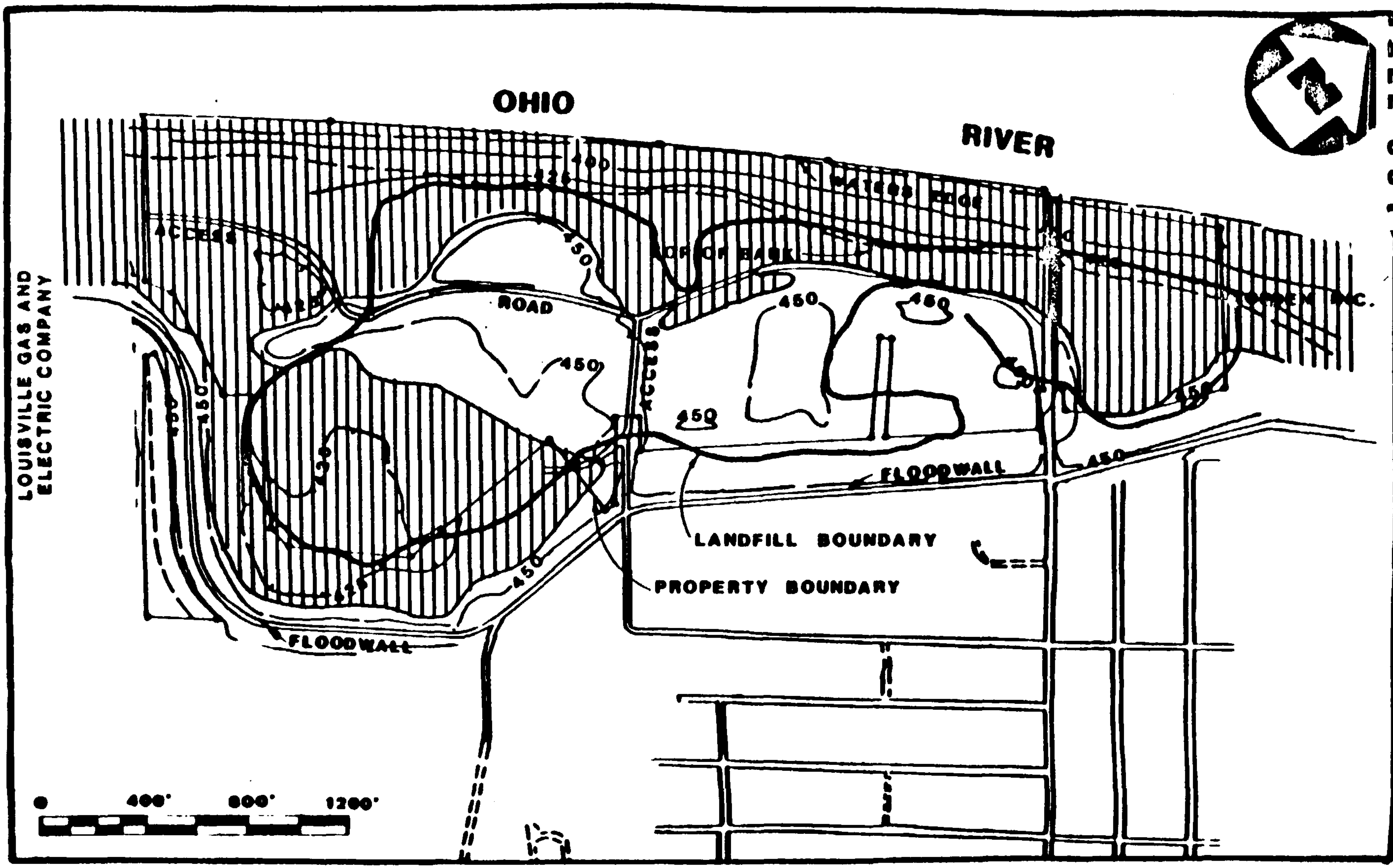


DESIGNATED 100-YEAR FLOOD LEVEL
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

LEGEND

BOUNDARY OF FILL

447.6 FEET MSL

FIGURE 5-5

NUS CORPORATION
A Halliburton Company

The designated 500-year flood level is 452 feet amsl and represents the Army Corps of Engineers' Standard Project Flood (see Figure 5-6). This Standard Project Flood is based on a flood which occurred in 1937 and reached 458.6 feet amsl. This is the greatest flood on record and is believed to be the largest flood likely to occur in this area. The Lees Lane Landfill is bordered on the east and south by a flood protection levee. This levee is part of an extensive system of levees and concrete walls designed and constructed by the Corps of Engineers to protect the City of Louisville and the adjacent highly developed county areas from a flood equal to the flood of 1937. Since the site is located on the river-side of the levee, a 500-year flood would inundate the majority of the landfill (Ecology & Environment, Inc., 1981).

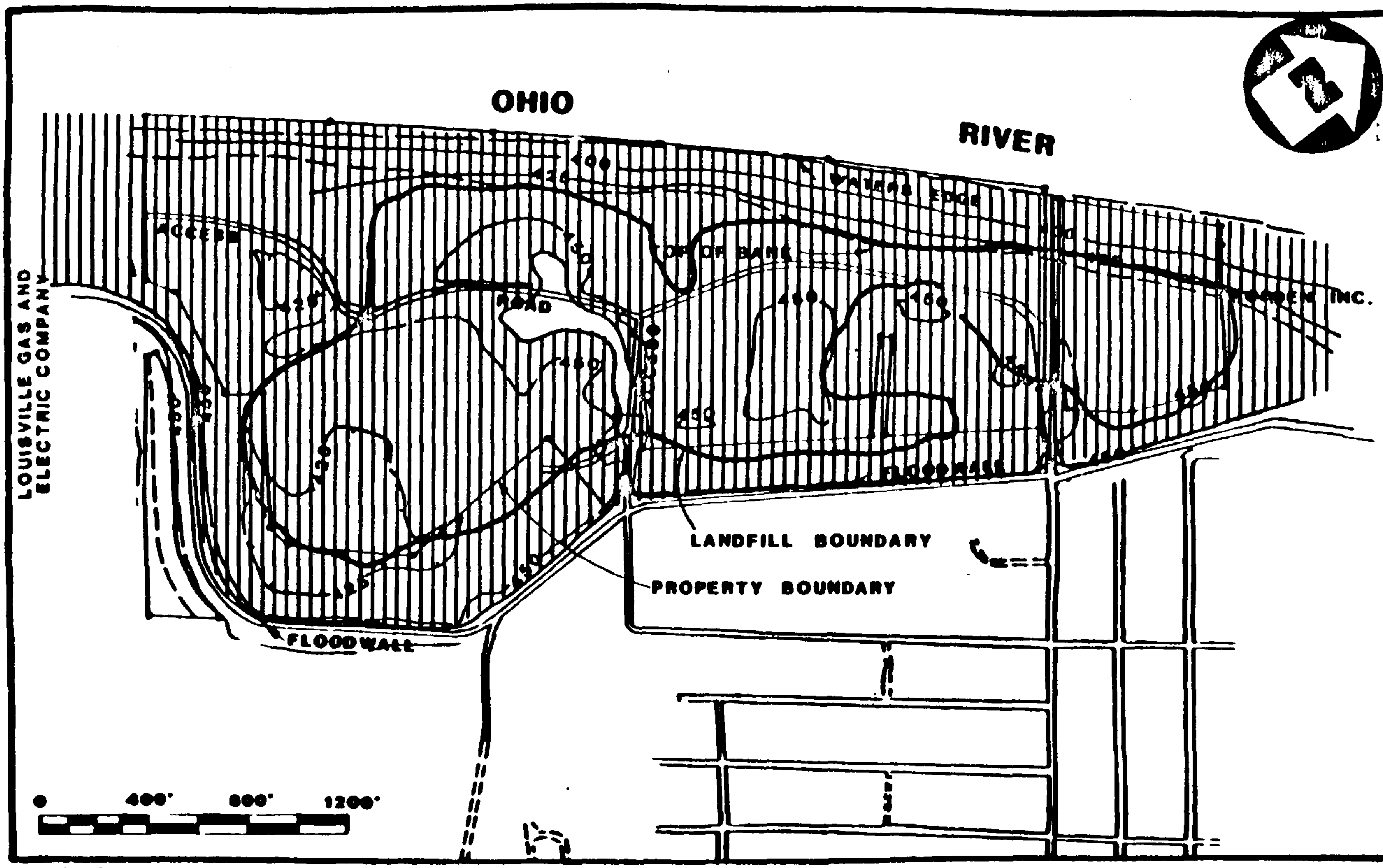
5.1.3.2 Effects on Landfill

The flooding of the Lees Lane Landfill Site by the Ohio River can have two potential effects on the site: the floodwaters may disturb the surface cover and the Ohio River has an increased potential during flooding for gradually eroding the western bank of the landfill. Both of these effects could potentially expose wastes which may have been buried at shallow depths and increase the potential for contaminants to be washed offsite into the Ohio River.

5.1.3.2.1 Removal of Cover

The Lees Lane Landfill Site was not filled to capacity and has, to date, undergone no formal closure operations. As a result, the Southern Tract contains two depressions with steep slopes. Due to the lack of backfill and regrading, runon during flooding may erode these steep slopes. Vegetation covers the landfill except in a few areas where the site has been denuded by surface disposal. This vegetation has helped to control erosion in most areas of the landfill.

The landfill's proximity to the Ohio River makes it susceptible to runon during flood stage. The average duration of all floods on record at Louisville is about 12 days and the longest flood duration recorded was 23 days. Channel velocities during flood stage can reach 11 feet per second (ft/sec). Although velocities on the



DESIGNATED 500-YEAR FLOOD LEVEL - STANDARD PROJECT FLOOD
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

LEGEND

- BOUNDARY OF FILL
- 452.0 FEET MSL

FIGURE 5-6

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floodplain can vary widely, overbank velocities are typically less than 3 ft/sec making erosional problems less severe (Army Corps of Engineers, 1982).

5.1.3.2.2 Bank Erosion

The western boundary of the Lees Lane Landfill abuts the Ohio River, with a portion of this boundary being characterized by a moderate to steep slope. This close proximity to the river, in conjunction with the steepness of slope, gives this particular area of the site a potential for erosion and bank failure during flood stages on the Ohio River that occur as frequently as every 1.2 years. Visual inspection of the bank reveals exposure of vegetation root systems, making the erosion due to river flow readily apparent.

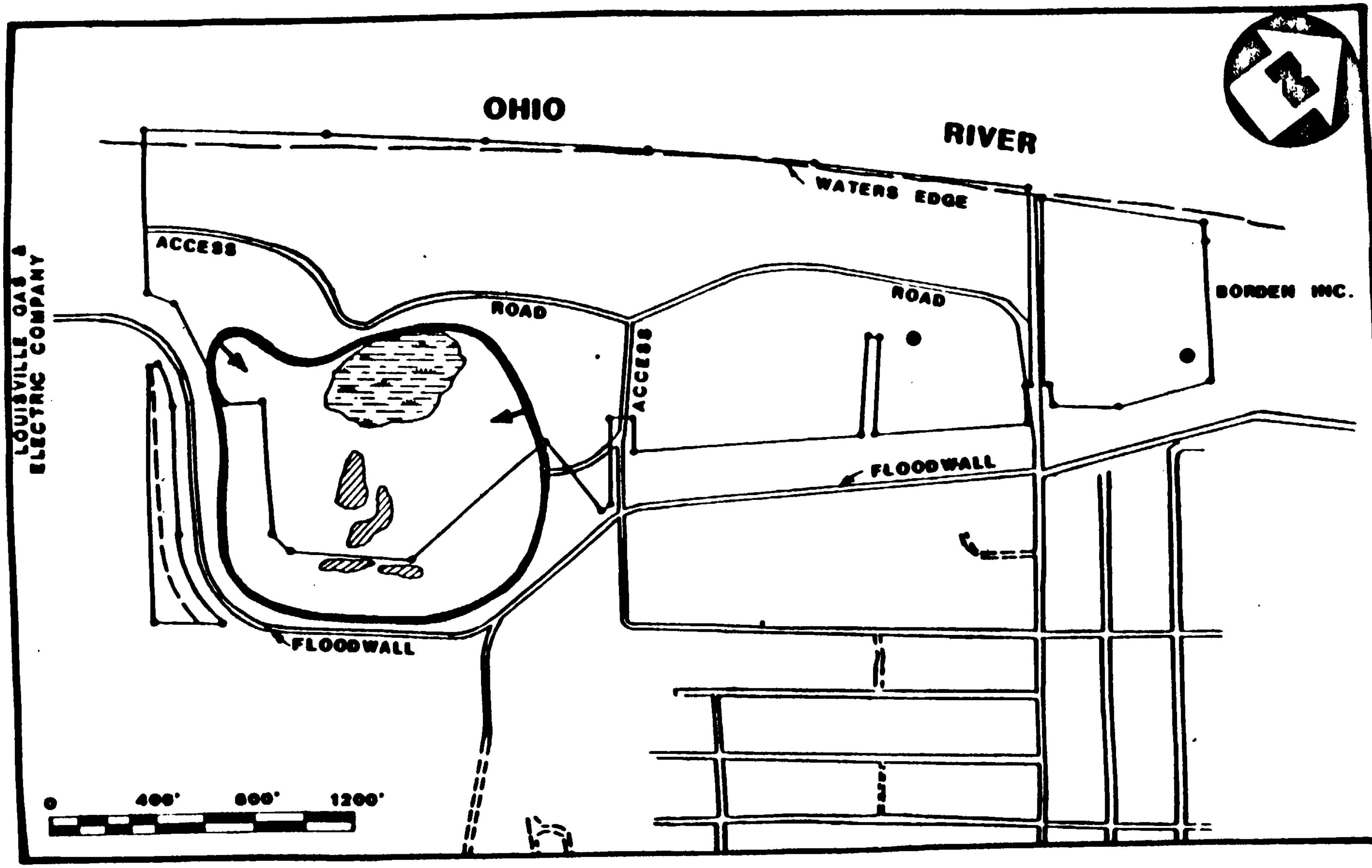
Refuse has been repeatedly noted along the Central Tract of the river bank. Although some of the material may be attributed to an upstream source, several areas of the bank contain partially exposed material. It appears that the trash along the river terrace may have been pushed from the landfill over the river bank. A magnetometer survey of the bank was conducted as part of the RI to determine the areal extent of ferromagnetic material along the river bank. (For a discussion of the survey, see Section 3.2.2.1). The results of the survey indicate that ferromagnetic materials are located along two-thirds of the river bank. These areas, which registered 800 to 1,200 gammas above background, were detected along the Central and Northern Tracts (see Figures 3-4 and 3-5).

5.2 Onsite Surface Water Bodies

There are four areas of surface water on the landfill property, one in each of the Northern and Central Tracts and two in the Southern Tract. There do not appear to be any hydraulic connections between the tracts (see Figure 5-7).

5.2.1 Marsh Area

There is a large wet area in the middle of the Southern Tract of the landfill covering approximately six acres. This is a flat area supporting a thick growth of cattails and other emergent reeds and grasses in and among the standing water.



ONSITE WETLANDS AND STANDING WATER
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

LEGEND

- OPEN POND
- MARSHY AREA
- STANDING WATER
- AREA POTENTIALLY DRAINING TO POND

FIGURE 5-7

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The water is probably a combination of rainwater and some surface runoff, although there were no apparent runon or runoff drainage pathways.

5.2.2 Large Open Ponds

There is a large depression in the southeast corner of the landfill covering approximately six acres of the Southern Tract. At the time of sampling in November 1984, there were two small ponds: a long, narrow pond, and a large, open pond in this area. In November, the three smallest ponds contained some open water with emergent vegetation covering about half of the water's surface. The largest pond consisted of an area of open water with emergent vegetation growing around the edges. Willows and other young hardwoods were growing, scattered among the ponds. By January 1985, all of these ponds had merged into one contiguous water body.

Based on field observations and a review of historic aerial photographs, it appears that this area was part of the original quarry excavations and was not filled during landfill operations. It is the lowest area of the landfill and therefore collects surface runoff from much of the Southern Tract. The estimated surface area draining into these ponds is based on existing topography and is indicated on Figure 5-2.

5.2.3 Standing Water

During the November 1984 investigation, the landfill surface was inspected for areas of standing water which could be sampled. Two small areas of ponded water were located in the Northern and Central Tracts of the landfill. Neither pond had obvious runon or runoff drainage pathways. Furthermore, because of the limited areal extent and the shallow depth, these two areas appear to be seasonal collections of rainwater and may be dry during part of the year.

The pond in the Northern Tract was located in an area densely vegetated with grasses, vines, and other herbaceous plants and had an overstory of mixed hardwood saplings and young trees. The pond was actually two small adjacent pools of water covering a total area of approximately 10 feet by 20 feet. Each pool was less than one foot deep. The water was clear, but the pond bottom had a thick layer of detritus and partially decomposed leaf matter.

The pond in the Central Tract was also surrounded by thick grasses and herbs. Several sumacs were growing around the pond's border. The water covered an area of approximately 10 feet by 10 feet and was approximately one foot deep. The surface had a slight oil sheen near the water's edge.

5.3 Site Drainage

The Lees Lane Landfill Site has a relatively flat, but hummocky, topography. The irregularities in the landfill surface were partly created by the quarrying and landfilling operations. The Northern Tract is mostly flat and forested. The Central Tract is also fairly flat with some undulations possibly due to subsidence of the fill. The Southern Tract has the greatest variations in topography. There is a small pocket in the southwest corner of this tract and a larger depression in the southeast corner. The elevation of the site ranges from a low point on the Ohio River of 383 feet amsl to a high point on the levee of 460 feet amsl. The landfill proper, not including the river bank terrace, has an average elevation of approximately 445 feet amsl and slopes slightly toward the south. The lowest point on the landfill proper is 414 feet amsl measured at the water surface on the pond in the southeast depression in the Southern Tract (see Figure 2-2).

The site drainage is directly influenced by the topography and by the flood protection levee which borders the site on the east and south. This levee, in addition to protecting the upgradient property from flooding, prevents upland runoff from flowing over the landfill surface and diverts the runoff into Mill Creek Cutoff above the levee. Therefore, the landfill is fairly isolated by the levee from the surrounding land. Furthermore, there are no streams flowing across the site. Most rain or floodwater which falls on the landfill surface either percolates into the ground or flows westward into the Ohio River. Due to the slightly higher topography in the Northern Tract, very little surface water flows northward. Some of the surface water may flow to the south-southeast into the small section of Mill

Creek Cutoff which flows through the levee and empties immediately into the Ohio River (see Figure 2-1). The remainder of the water flowing over the landfill either infiltrates the cover, is lost to evapotranspiration, or is trapped in the depressions found on the surface.

During the RI, there were two small areas of standing water in the Northern and Central Tracts. These areas were fairly flat and low and were probably created by small areas of low-permeability surface material. There did not appear to be any runon or runoff drainage pathways between these two areas. No surface water interconnections were apparent between these tracts and the Southern Tract.

The Southern Tract has the lowest elevations on the landfill proper and therefore collects the most surface water. In November 1984 there was a marshy area near the middle of the Southern Tract and a large depression in the southeast corner. This depression was filled with four open ponds in November 1984 which had formed one large contiguous pond by January 1985. No water was observed in the smaller depression in the southwest section of the Southern Tract.

5.4 Sampling Program

The surface water sampling investigation was designed to determine the presence or probable absence of contaminants in water bodies on the surface of the landfill. Both water and sediment samples were collected from the onsite water bodies. Soil samples were collected to determine if surface contamination was present in obvious "hot spot" areas which could cause a public health hazard through direct contact. Additionally, water samples from temporary well points, along the river bank, and from the Ohio River, immediately adjacent to the site, were collected to compare the chemical characteristics of the shallow groundwater near the western border of the landfill with the Ohio River as it flows past the site. All samples collected were analyzed for the Hazardous Substances List parameters (see Appendix F). The analyses were conducted by EPA's National Contract Laboratory Program. The field sampling data, including sampling date, time, temperature and pH, can be found in Appendix H.

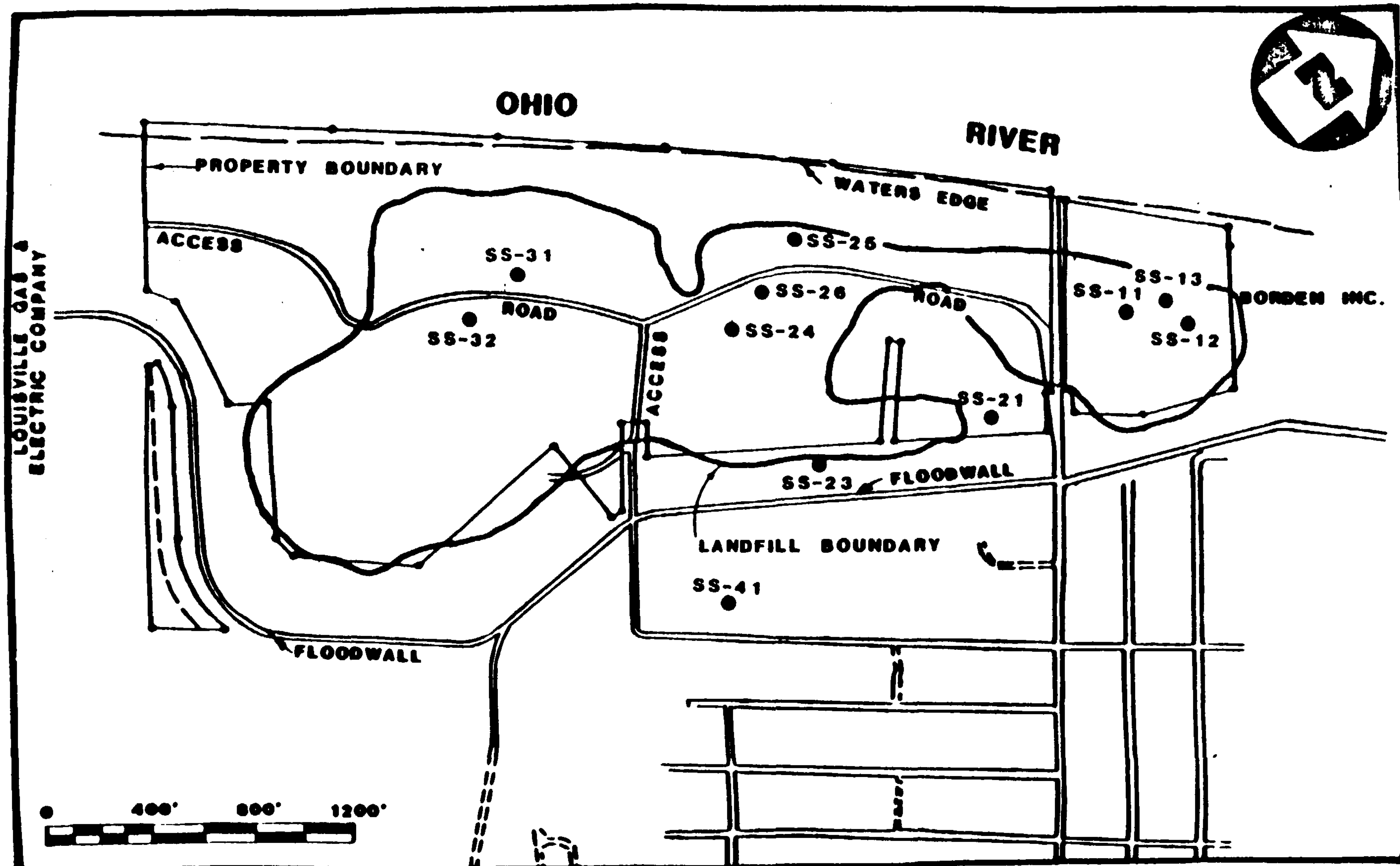
5.4.1 Onsite Surface Soils

Prior to the sampling conducted for the Remedial Investigation, no surface soil samples from the landfill cover had been analyzed. Contamination of the surface soil may have resulted from leaking drums stored on the surface, from spillage during flooding or site cleanup activities, and from wastes disposed directly on the ground surface. If the surface soil is contaminated, it may pose a hazard to the public through direct contact and through the inhalation/ingestion of toxic airborne particulates. Erosion of these surface soils and runoff into the Ohio River or other offsite areas may create a potential environmental hazard. Figure 5-8 shows the location of the surface soil sample collection points. The sample location descriptions can be found in Appendix G.

Eleven surface soil samples were collected and analyzed in November 1984. Eight of the sample locations were selected because the surface was crusted, discolored or moist, or because the area showed an obvious lack of vegetation. Two samples were collected from areas with exposed drums. These ten samples were not intended to characterize the landfill surface, but rather to identify contaminants posing direct contact and runoff hazards. Additionally, one sample was collected from an undisturbed area in Riverside Gardens on the upgradient side of the levee, and was intended to serve as a background sample.

Specifically, three soil samples were collected from barren areas in the Northern Tract (see Table 5-3). In the Central Tract, four soil samples were collected from denuded areas and one sample was collected along the River bank near an area of exposed drums (see Tables 5-4 and 5-5). Two soil samples, one from a barren area and one from an area of exposed drums, were collected from the Southern Tract (see Table 5-6).

The ten landfill surface soil samples were composited from four quadrants within each sample location. Soil from each quadrant was collected from the top six inches using a clean, teflon-lined spoon and placed in a pyrex dish. Debris, such as rocks and vegetation, was removed and the soil was mixed into a homogeneous sample. The background sample was collected from the backyard of a Riverside



SURFACE SOIL SAMPLING LOCATIONS
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

LEGEND

● - SAMPLE LOCATIONS

FIGURE 5-8

NUS CORPORATION
A Halliburton Company

LEE 001 0009975

TABLE 5-3
SUMMARY OF ANALYTICAL RESULTS OF SOIL SAMPLES
"HOT SPOT" SURFACE SOIL - NORTHERN TRACT
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

	Background	Northern Tract		
Parameter in mg/kg	SS-41 11/84	SS-11 11/84	SS-12 11/84	SS-13 11/84
Inorganics				
Silver	9.3	4.8	-	-
Arsenic	24	22	22	25
Barium	92	120	140	130
Beryllium	1.1	0.8	1.1	1.4
Cadmium	4J	6J	6J	4J
Cobalt	11	23	15	12
Chromium	20J	200J	20J	50J
Copper	20J	300J	30J	30J
Nickel	10J	200J	20J	20J
Lead	50J	60J	70J	50J
Vanadium	40J	30J	20J	30J
Zinc	77	530	170	95
Mercury	0.2	0.074	-	0.1
Aluminum	8,100	8,100	8,800	8,700
Manganese	1,200	1,000	1,100	960
Calcium	1,900	3,900	3,500	2,400
Magnesium	2,000J	10,000J	3,000J	3,000J
Iron	35,000	29,000	31,000	36,000
Sodium	5,000J	-	10,000J	10,000J
Potassium	1,100	1,300	1,800	1,600
Parameter in ug/kg				
Purgeable Organics				
Unidentified Compounds	3-10J	-	-	-
Pesticides/PCBs				
PCB-1260	-	40JN	40J	40J

- Not detected.
J Estimated value.
N Presumptive evidence of presence of material.

LEE 001 000977

TABLE 5-4
SUMMARY OF INORGANIC ANALYTICAL RESULTS OF SOIL SAMPLES
"HOT SPOT" SURFACE SOIL - CENTRAL TRACT
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

	Background	Central Tract				
Parameter in mg/kg	SS-41 11/84	SS-21 11/84	SS-23 11/84	SS-24 11/84	SS-25 11/84	SS-26 11/84
Inorganics						
Silver	9.3	-	-	3.4	-	6.8
Arsenic	24	24	15	23	19	15
Barium	92	110	67	70	130	81
Beryllium	1.1	-	-	0.62	0.89	0.45
Cadmium	4J	6J	10J	4J	9J	5J
Cobalt	11	3.7	14	35	22	21
Chromium	20J	20J	400J	2,000J	30J	900J
Copper	20J	30J	60J	40J	40J	70J
Nickel	10J	5J	30J	100J	30J	50J
Lead	50J	100J	2,000J	70J	70J	70J
Antimony	-	-	47	-	-	37
Vanadium	40J	30J	10J	40J	20J	40J
Zinc	77	46	220	110	170	170
Mercury	0.2	160	0.61	0.51	0.46	0.44
Aluminum	8,100	3,300	4,800	7,700	9,200	7,100
Manganese	1,200	380	410	600	1,300	530
Calcium	1,900	610	2,500	4,000	7,800	2,800
Magnesium	2,000J	1,000J	2,000J	50,000J	5,000J	50,000J
Iron	35,000	46,000	21,000	41,000	28,000	27,000
Sodium	5,000J	10,000J	20,000J	10,000J	10,000J	4,000J
Cyanide	-	-	9J	-	0.7J	-
Potassium	1,100	1,600	1,500	1,300	1,600	1,100

- Not detected.
J Estimated value.

LEE 001 000978

TABLE 5-5
SUMMARY OF ORGANIC ANALYTICAL RESULTS OF SOIL SAMPLES
"HOT SPOT" SURFACE SOIL - CENTRAL TRACT
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

	Background	Central Tract				
Parameter in ug/kg	SS-41 11/84	SS-21 11/84	SS-23 11/84	SS-24 11/84	SS-25 11/84	SS-26 11/84
Extractable Organics						
Quality Control indicates data are unuseable.						
Purgeable Organics						
Toluene	-	69	-	10	-	-
C_3 Alkyl Benzene	-	-	-	-	-	60
Acetone	-	-	240	-	-	-
Dichlorocyclobutane	-	-	-	-	-	-
Propanoic Acid, Methylmethyl Ester	-	-	-	-	2	-
Butanoic Acid, Methyl Ester	-	-	-	-	1JN	-
Methylpropanal	-	-	-	-	7JN	-
Methylbutanone	-	-	-		3JN	-
Unidentified Compounds	3-10J	-	3-10J	-	1-20J	-
Pesticides/PCBs						
Chlordane (Tech, Mixture)	-	-	140	-	-	-
PCB-1260	-	-	-	-	40J	40J

- Not detected.
J Estimated value.
N Presumptive evidence of presence of material.

TABLE 5-6
SUMMARY OF ANALYTICAL RESULTS OF SOIL SAMPLES "HOT SPOT" SURFACE SOIL - SOUTHERN TRACT LEES LANE LANDFILL SITE JEFFERSON COUNTY, KENTUCKY

	Background	Southern Tract	
	SS-41 11/84	SS-31 11/84	SS-32 11/84
Parameter in mg/kg			
Inorganics			
Silver	9.3	4.4	5.4
Arsenic	24	11	-
Barium	92	46	59
Beryllium	1.1	-	0.48
Cadmium	4J	-	4J
Cobalt	11	7.2	13
Chromium	20J	10J	20J
Copper	20J	20J	40J
Nickel	10J	10J	10J
Lead	50J	50J	80J
Vanadium	40J	10J	30J
Zinc	77	60	120
Mercury	0.2	0.21	0.34
Aluminum	8,100	3,600	7,000
Manganese	1,200	310	360
Calcium	1,900	1,800	2,500
Magnesium	2,000J	2,000J	3,000J
Iron	35,000	21,000	31,000
Sodium	5,000J	-	5,000J
Potassium	1,100	800	1,200
Parameter in ug/kg			
Extractable Organics			
Unidentified Compounds	-	4-300,000J	-
Purgeable Organics			
Acetone	-	-	100
1,1,1-Trichloroethane	-	6J	12
Toluene	-	17	-
Ethyl Benzene	-	-	180
Total Xylenes	-	-	740
Methylmethylpentylcyclopropane	-	-	1
Unidentified Compounds	3-10J	-	-
Unidentified Alkyls	-	-	4-20J

- Not detected.
J Estimated value.

Gardens' resident between the levee and Putnam Avenue adjacent to the Central Tract of the landfill. The sample was composited from a forested area with a thick ground cover of herbs, vines, and seedlings. This background sample was collected following the same procedures used for the other ten surface soil samples.

5.4.2 Onsite Surface Water Bodies

Prior to the sampling conducted for the Remedial Investigation, no surface water or sediment samples from onsite water bodies had been analyzed. Contamination of onsite water bodies may have resulted from runoff of water and erosion of soil from other portions of the site which may have had wastes stored on the surface in the past. If contaminants are present, these water bodies may pose a hazard to the public and nearby wildlife through direct contact.

Ten water and sediment samples were collected from onsite surface water bodies to determine the presence or probable absence of contaminated water and/or sediment on the landfill surface and the potential for a direct contact hazard to the local public. Additionally, the sediments found in the large, open ponded area are considered to be characteristic of the contaminants likely to be transported during flooding or as a result of normal erosional processes. The locations of the sample collection points are shown on Figure 5-9 and the sample location descriptions can be found in Appendix G.

Specifically in the Northern and Central Tracts, two water and sediment samples were collected from two small, low areas containing ponded water (see Tables 5-7 and 5-8). In the Southern Tract, three water and sediment samples were collected from the large, flat marshy area (see Tables 5-9 and 5-10). Also in the Southern Tract, four water and sediment samples were collected in November 1984 from the large depression which contained four open water bodies. Another water and sediment sample was collected from this same area in January 1985 (see Tables 5-11 and 5-12).

The water samples from these onsite surface water bodies were collected by submerging the sample containers in an upright position. If the water was not deep

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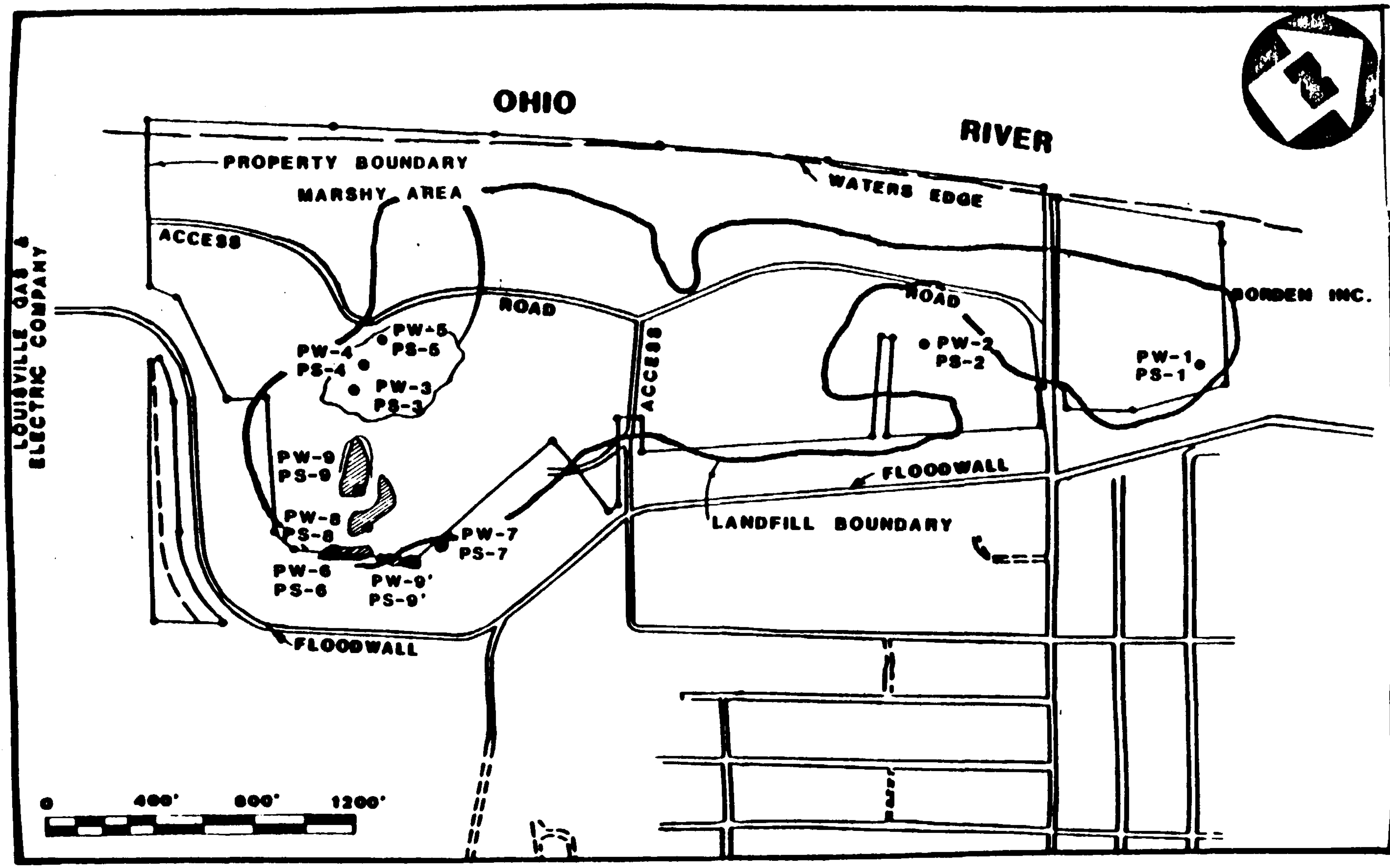


ONSITE SURFACE WATER AND
SEDIMENT SAMPLING LOCATIONS
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

LEGEND

- OPEN PONDED WATER
- SAMPLE LOCATION

FIGURE 5-9

NUS CORPORATION
A Halliburton Company

TABLE 5-7
SUMMARY OF ANALYTICAL RESULTS OF SURFACE WATER SAMPLES
STANDING WATER - NORTHERN AND CENTRAL TRACTS
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Parameter in ug/l	Northern Tract PW-1 11/84	Central Tract PW-2 11/84
Inorganics		
Barium	58	77
Chromium	-	5
Copper	12	14
Nickel	8.8	11
Lead	6J	-
Vanadium	5.3	-
Zinc	53	33
Aluminum	1,900	230
Manganese	240	270
Calcium	13,000	66,000
Magnesium	4,100	18,000
Iron	4,300	1,800
Potassium	5,000	10,000
Purgeable Organics		
Chloroethane	-	22
1,1-Dichloroethane	-	17
Chloroform	-	5J
1,1,1-Trichloroethane	-	5J
Trichloroethene	-	5J
Benzene	-	5J
1,1,2-Trichloroethane	-	5J
Ethyl Benzene	-	5J

- Not detected.
J Estimated value.

TABLE 5-8
SUMMARY OF ANALYTICAL RESULTS OF SEDIMENT SAMPLES
STANDING WATER SEDIMENTS - NORTHERN AND CENTRAL TRACTS
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Parameter in mg/kg	Northern Tract PS-1 11/84	Central Tract PS-2 11/84
Inorganics		
Silver	6.2	-
Arsenic	15	10
Barium	130	77
Beryllium	0.85	-
Cadmium	4J	-
Cobalt	8.5	12
Chromium	20J	20J
Copper	20J	60J
Nickel	10J	20J
Lead	50J	100J
Vanadium	30J	20J
Zinc	79	180
Mercury	-	11
Aluminum	8,200	5,200
Manganese	600	390
Calcium	2,500	4,300
Magnesium	3,000J	2,000J
Iron	26,000	22,000
Sodium	10,000J	20,000J
Potassium	1,700	1,700
Parameter in ug/kg		
Extractable Organics		
Naphthalene	-	250J
4-Bromophenyl Phenyl Ether	-	310J
Phenanthrene	-	470J
Benzyl Butyl Phthalate	1,600	-
Bis (2-Ethylhexyl) Phthalate	3,000J	3,400JN
Chrysene	-	1,100
Di-N-Butylphthalate	-	511J
Purgeable Organics		
Benzene	-	15J
Chlorobenzene	-	6J
Methyl Ethyl Ketone	9J	-
Acetone	300JN	-

- Not detected.
J Estimated value.
N Presumptive evidence of presence of material.

000984
LEE 001

TABLE 5-9
SUMMARY OF ANALYTICAL RESULTS OF SURFACE WATER SAMPLES
MARSH AREA WATER - SOUTHERN TRACT
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

	Southern Tract		
Parameter in ug/l	PW-3 11/84	PW-4 11/84	PW-5 11/84
Inorganics			
Barium	44	34	69
Cadmium	-	5.4	-
Copper	6.1	11	15
Nickel	-	9.1	-
Lead	-	4J	-
Zinc	9.9	19	16
Aluminum	70	500	300
Manganese	36	110	240
Calcium	70,000	14,000	100,000
Magnesium	21,000	6,800	27,000
Iron	100	1,100	690
Sodium	-	15,000	32,000
Potassium	2,800	9,500	17,000

Organics

None detected.

- Not detected.
J Estimated value.

TABLE 5-10
SUMMARY OF ANALYTICAL RESULTS OF SEDIMENT SAMPLES
MARSH AREA SEDIMENTS - SOUTHERN TRACT
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

	Southern Tract		
Parameter in mg/kg	PS-3 11/84	PS-4 11/84	PS-5 11/84
Inorganics			
Arsenic	14	14	21
Barium	90	95	130
Beryllium	0.77	0.73	0.88
Cadmium	-	4J	5J
Cobalt	15	14	20
Chromium	30J	10J	30J
Copper	40J	30J	40J
Nickel	30J	20J	20J
Lead	100J	30J	80J
Vanadium	20J	20J	30J
Zinc	130	82	120
Mercury	0.29	0.27	0.28
Aluminum	7,800	6,800	12,000
Manganese	540	420	720
Calcium	5,100	2,400	3,000
Magnesium	4,000J	3,000J	5,000J
Iron	28,000	23,000	38,000
Sodium	20,000J	20,000J	20,000J
Potassium	1,600	1,500	2,300
Parameter in ug/kg			
Extractable Organics			
Benzyl Butyl Phthalate	-	3,000JN	-
Unidentified Compounds	-	16-30,000J	-

- Not detected.

J Estimated value.

N Presumptive evidence of presence of material.

TABLE 5-11
SUMMARY OF ANALYTICAL RESULTS OF SURFACE WATER SAMPLES
POND WATERS - SOUTHERN TRACT
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Parameter in ug/l	PW-7 11/84	PW-9' 1/85	PW-6 11/84	PW-8 11/84	PW-9 11/84
	Southern Tract				
Inorganics					
Silver	-	-	-	-	29
Barium	36	66	51	72	55
Beryllium	-	-	-	-	0.9
Cadmium	-	-	-	-	5.5
Cobalt	-	-	-	-	8.3
Chromium	-	R	6.2	5.4	6.2
Copper	10	9.5	12	12	19
Nickel	-	15	12	39	11
Lead	-	-	10J	5J	2J
Antimony	-	-	-	-	86
Vanadium	-	-	8.5	5.3	6.3
Zinc	44	46J	25	49	46
Aluminum	1,200	550	3,800	1,900	2,000
Manganese	270	140J	72	260	260
Calcium	9,900	44,000	14,000	42,000	14,000
Magnesium	4,700	13,000	3,900	12,000	4,500
Iron	2,000	2,300	4,800	3,200	3,800
Sodium	-	23,000J	-	22,000	-
Potassium	8,600	13,000	4,600	13,000	6,600

Organics

None detected.

\- Not detected.
R Quality control indicates data are unuseable.
J Estimated value.

LEE 001
000936

TABLE 5-12
SUMMARY OF ANALYTICAL RESULTS OF SEDIMENT SAMPLES
POND SEDIMENTS - SOUTHERN TRACT
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

	Southern Tract				
Parameter in mg/kg	**PS-7 11/84**	**PS-9' 1/85**	**PS-6 11/84**	**PS-8 11/84**	**PS-9 11/84**
Inorganics					
Silver	-	-	-	-	4.9
Arsenic	12	5.4	17	8.4	27
Barium	69	84	110	57	130
Beryllium	0.5	0.54	-	0.45	0.84
Cadmium	-	4.0	-	-	-
Cobalt	10	9.1	12	8.3	16
Chromium	20J	9.8	20J	20J	20J
Copper	20J	14	30J	30J	40J
Nickel	20J	12	20J	30J	32
Lead	10J	21J	R	50J	R
Tin	-	-	41	-	-
Vanadium	20J	13	20J	10J	30J
Zinc	67	50	100	120	140
Mercury	0.12	-	-	-	-
Aluminum	6,300	4,000	8,500	4,400	12,000
Manganese	310	560J	800	290	470
Calcium	1,300	11,000	2,400	3,700	2,500
Magnesium	2,000J	2,500	3,000J	2,000J	4,000J
Iron	20,000	15,000	26,000	15,000	30,000
Sodium	-	R	-	-	-
Potassium	-	-	1,300	660	1,700
Parameter in ug/kg					
Extractable Organics					
Phenanthrene	-	-	-	-	1,800
Di-N-Butylphthalate	-	200J	-	-	-
Fluoranthene	-	-	-	-	2,200
Pyrene	-	-	-	-	1,400
Chrysene	-	-	-	-	900

\- Not detected.
J Estimated value.
R Quality control indicates data are unuseable.

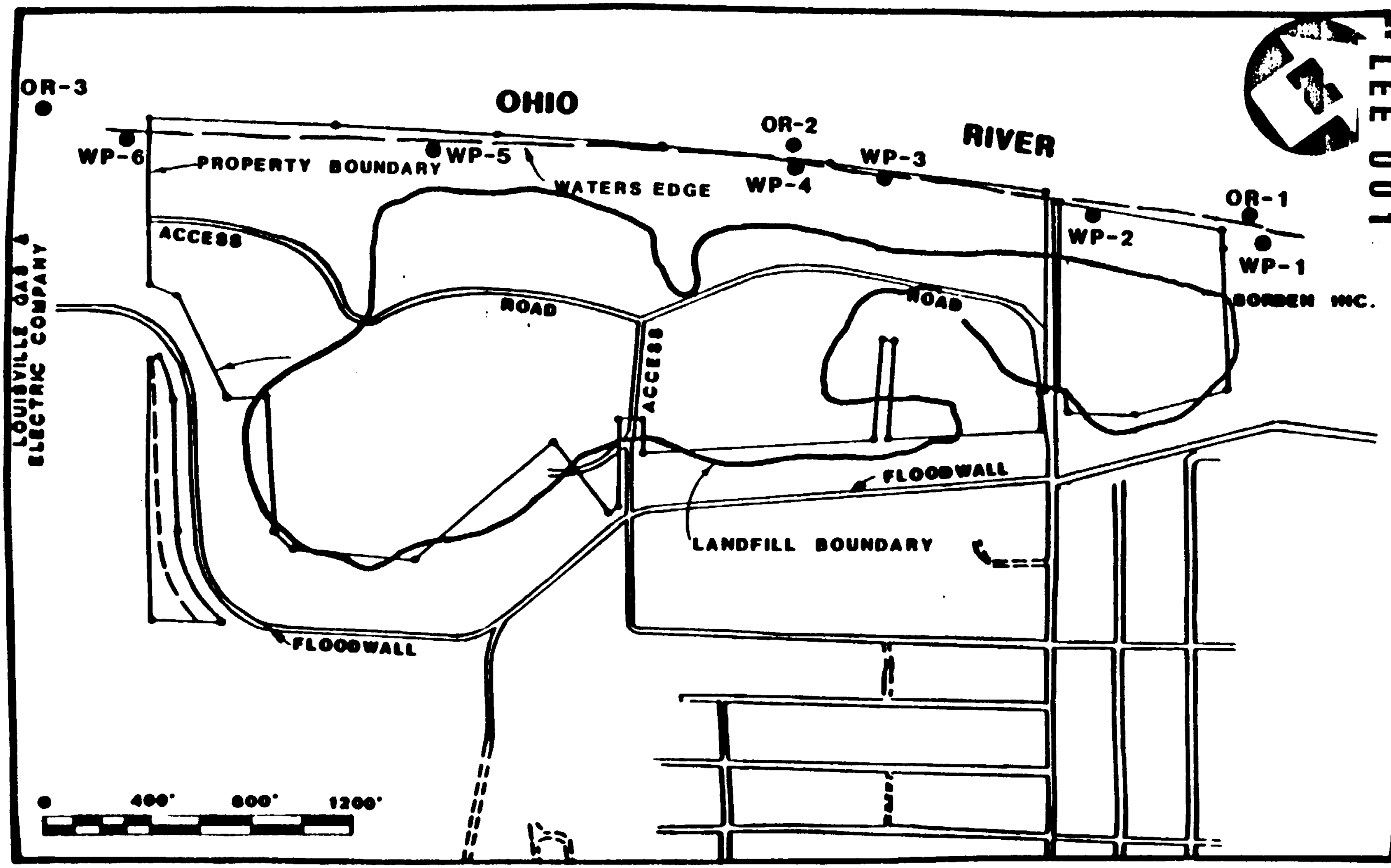
LEE 001 00987

enough to fill the gallon glass bottle, the pint glass bottle was used to fill the larger bottle. All other sample containers, including the vials for volatile organics, were filled directly from the ponded water. In order to minimize the amount of suspended solids, the water samples were collected before the sediment samples. Sediment samples were collected near the water sampling point, using a clean, stainless steel spoon. The sediment was put into a clean pyrex bowl and mixed thoroughly. Any debris, such as rocks or vegetation, was removed before the sediment was transferred into the sample containers.

5.4.3 Ohio River and Shallow Groundwater

Due to the proximity of the Lees Lane Landfill to the Ohio River, there is a potential for the landfill to contribute contaminants to the already polluted Ohio River via several different pathways. Surface runoff may carry contaminated water and/or sediments into the river. Flooding of the landfill with the subsequent recession of the flood waters could also carry surface contaminants into the river. Additionally, due to the hydraulic connection between the alluvial aquifer beneath the landfill and the Ohio River, leachate in the groundwater from the landfill may discharge into the river. Leachate seeps have been observed along the river bank during low water levels.

In an attempt to determine the presence or probable absence of contaminants in nearshore locations along the Ohio River, water samples were collected from nine locations along the river (see Figure 5-10). Six well points were installed and sampled on the lower river bank terrace. The locations for these well points were selected near areas where leachate seeps had been observed and noted during the site reconnaissance. These well points were intended to intercept leachate flowing from the landfill directly into the Ohio River. Water samples were collected from the Ohio River at three nearshore locations: upstream of the landfill near well point #1, adjacent to the central section of the landfill near well point #4, and downstream of the landfill near well point #6 (see Tables 5-13 and 5-14). These samples were not intended to characterize the Ohio River water quality, but rather to determine if contaminants found in the leachate were also present in the Ohio River adjacent to the landfill. The tables presenting the data from well points #2, #3, and #5, which were installed in between the points where Ohio River samples



OHIO RIVER AND WELL POINT SAMPLING LOCATIONS
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

LEGEND
● SAMPLE LOCATIONS

FIGURE 5-10

NUS CORPORATION
A Halliburton Company

LEE 001
0009989

LEE 00904

TABLE 5-13
SUMMARY OF INORGANIC ANALYTICAL RESULTS OF WATER SAMPLES
SHALLOW GROUNDWATER AND NEAR-SHORE OHIO RIVER
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Parameter in ug/l	Northern Tract WP-1 11/84	Northern Tract OR-1 11/84	Central Tract WP-4 11/84	Central Tract OR-2 11/84	Southern Tract WP-6 11/84	Southern Tract OR-3 11/84
Inorganics						
Arsenic	-	-	20J	-	-	-
Barium	210	-	400	-	220	-
Chromium	29	-	29	-	33	-
Copper	30	-	42	-	-	-
Nickel	41	-	55	-	46	-
Lead	83	-	17	-	18	-
Zinc	160	21	260	-	140	32
Aluminum	16,000	690	15,000	600	21,000	1,000
Manganese	1,400	83	2,200	75	940	120
Calcium	130,000	39,000	170,000	40,000	44,000	42,000
Magnesium	37,000	12,000	39,000	12,000	18,000	12,000
Iron	25,000	1,100	57,000	1,100	34,000	1,800
Sodium	16,000	31,000	49,000	28,000	-	28,000
Potassium	-	-	5,600	-	-	-

\- Not detected.
J Estimated value.

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TABLE 5-14
SUMMARY OF ORGANIC ANALYTICAL RESULTS OF WATER SAMPLES
SHALLOW GROUNDWATER AND NEAR-SHORE OHIO RIVER
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

	Northern Tract		Central Tract		Southern Tract	
Parameter in ug/l	WP-1 11/84	OR-1 11/84	WP-4 11/84	OR-2 11/84	WP-6 11/84	OR-3 11/84
Extractable Organics						
Pentanoic Acid	-	-	7JN	-	-	-
Octanoic Acid	-	-	6JN	-	-	-
Benzeneacetic Acid	-	-	10JN	-	-	-
Dodecanoic Acid	-	-	20JN	-	-	-
Tetradecanoic Acid	-	-	5JN	-	-	-
Unidentified Compounds	1-30J	3-10J	3-40J	1-10J	-	1-6J
Purgeable Organics						
Chloroform	-	4J	-	-	-	-
2-Propanol	20JN	-	300JN	-	-	-
Methyl Ethyl Ketone	-	10	-	-	-	-

- Not detected.
J Estimated value.
N Presumptive evidence of presence of material.

were collected, and the sample collection procedures for the well points can be found in Section 4.4.1.1. The sample location descriptions for all the well points and the Ohio River samples can be found in Appendix G.

The three Ohio River water samples were collected approximately two to three feet from the river bank by facing upstream and submerging the sample containers approximately one foot below the water surface.

5.5 Surface Media Characterization

The characterization of onsite surface water and sediment, and surface soils is being combined because the effects of one can not be separated from the other two. For instance, the onsite soils are expected to be the source of or the same as the sediments for the onsite water bodies. Surface water runoff over the onsite soils is expected to be a potential source of surface water contamination.

The surface media characterization for the Lees Lane Landfill Site consisted of five activities. The contaminants in the onsite surface water, sediments, and surface soils at the site were quantified through a sampling and analysis program and the results of this activity were presented in the previous section. The contaminants identified through sampling and analysis of groundwater were evaluated to determine the contaminants of interest based on both the concentrations and the sample locations. The results of this evaluation were presented in Section 4.5.1. The distribution of the contaminants of interest in sediments and surface soils were compared to investigate their relationship in terms of soil transport. The distribution of these contaminants in onsite surface water was evaluated to determine the potential for a hydraulic connection between the pond in the Southern Tract and groundwater. This information was then applied to the description of migration pathways. The potential public health effects were also identified.

5.5.1 Contaminants of Interest

The contaminants of interest include arsenic, barium, chromium, lead, manganese, and iron. These contaminants will be examined for each media. The public health concerns related to the contaminants of concern are discussed in further detail in Section 8.0.

5.5.2 Distribution of Contaminants

The onsite soil samples were collected from potential "hot spots" based on visual observation. These samples are probably characteristic of the soils sampled since soil concentrations are not expected to change significantly over time. However, these samples were not intended to be representative of the cover material, but were instead collected in an effort to determine if isolated portions of the landfill cover would require special remedial measures to protect the public from direct contact with contaminated soils. The ranges of concentrations found in these "hot spot" soil samples are presented by tract in Table 5-15. Since these are "hot spot" soil samples there is no reason to compare the samples by tract in terms of relative concentrations. However, the ranges shown in the table are similar for all samples collected and are similar to the background concentrations found in Riverside Gardens. The only exceptions are the slightly higher concentrations (2,000J mg/kg) of chromium and lead found in the Central Tract. Since these two samples contain higher concentrations of only one contaminant, the analyses are not representative of cover material concentrations and may be the result of indiscriminant dumping on the landfill surface. The higher chromium concentration was found in a sample (SS-24) collected near the access road on the river side of the tract and the higher lead concentration was found in a sample (SS-23) collected near the access road on the levee side of the tract. The two samples collected near areas with exposed drums (SS-25 and SS-31) did not show concentrations significantly different from the other onsite soils or the background sample.

The onsite sediment samples were collected from below standing water in the Northern and Central Tracts and from the marsh and the open ponded water in the Southern Tract. The distribution of these samples suggests that they are probably representative of the actual concentrations at the site at the time of sampling. The ranges of concentration for the contaminants of interest for these samples are also shown in Table 5-15. Again, all the samples appear similar to each other as well as similar to the offsite soil sample. A closer examination of the concentrations found in the sediment sample collected from below the standing

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TABLE 5-15
COMPARISON BY TRACT OF SELECTED CONSTITUENTS
ONSITE SOILS AND SEDIMENTS
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Parameter in mg/kg	Offsite Soils	Onsite Soils			Onsite Sediments		
		Northern Tract	Central Tract	Southern Tract	Northern Tract	Central Tract	Southern Tract
Arsenic	24	22-25	15-24	0-11	15	10	5.4-27
Barium	92	120-140	67-130	46-59	130	77	57-130
Chromium	20J	20J-200J	20J-2,000J	10J-20J	20J	20J	9.8-30J
Lead	50J	50J-70J	70J-2,000J	50J-80J	50J	100J	10J-100J
Manganese	1,200	960-1,100	380-1,300	310-360	600	390	290-800
Iron	35,000	29,000-36,000	21,000-46,000	21,000-31,000	26,000	22,000	15,000-38,000

J - Estimated value.

water in the Central Tract confirms that the slightly higher concentrations of chromium and lead found in separate soil samples collected from the Central Tract are probably the result of surface disposal of waste and can not be considered representative of the cover material. The similarity of the concentrations of the soil samples to the offsite soils suggests that the landfill cover material was probably derived from nearby native soils.

As indicated in Figure 5-7, runoff from most of the Southern Tract can be expected to drain into the ponded area located in the depression in the same tract. Although the soil samples collected from the Southern Tract were outside the area where runoff is expected to be directed toward the pond, the sediment samples collected from the wetlands in the Southern Tract are within this area. A comparison of these sediments was compiled in Table 5-16. The ranges of concentrations shown suggest little difference between the marsh and pond sediments and little difference between the sediments and offsite soils collected in Riverside Gardens.

The onsite surface water samples were collected from the same locations as the onsite sediment samples previously described and can be considered representative of the concentrations in surface water at the time of sampling. The ranges of concentrations for these samples is shown in Table 5-17. No contaminants of interest appear to vary significantly from tract to tract. It should be noted that benzene was detected in the standing water and sediment in the Central Tract (5J ug/l and 15J mg/kg, respectively).

The potential for groundwater discharge to the depression in the Southern Tract was evaluated since such a discharge could affect the remedial measures for the site. Monitor well LL-7 is located near the ponds and the bottom of the well is at approximately 390 feet above mean sea level (amsl). At the time the site was flown (June, 1984) for the aerial photography in support of the topographic mapping of the site, the water elevation in the pond was 414 feet amsl. Water levels measured in LL-7 during the RI ranged from approximately 397 to 404 feet amsl. Since this has been a dry year, these water levels are inconclusive as to the potential for groundwater discharge to the pond. However, during the period of the aerial photography, four distinct ponds were visible suggesting that the water level in the ponds might be comparable to the groundwater levels measured in November

Table 5-16
Comparison of Selected Constituents
Marsh and Pond Sediments in the Southern Tract
Lees Lane Landfill Site
Jefferson County, Kentucky

Parameter in mg/kg	Offsite Soils	Marsh Sediments	Pond Sediments
Arsenic	24	14-21	5.4-27
Barium	92	90-130	57-130
Chromium	20J	10J-30J	9.8-20J
Lead	50J	30J-100J	10J-50J
Manganese	1,200	420-720	290-800
Iron	35,000	23,000-38,000	15,000-30,000

J - Estimated value.

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TABLE 5-17
COMPARISON BY TRACT OF SELECTED CONSTITUENTS
ONSITE SURFACE WATER
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

	Onsite Surface Water				Top of Alluvial Aquifer	
Parameter in ug/l	Northern Tract Standing Water	Central Tract Standing Water	Southern Tract Marsh	Southern Tract Pond	Upgradient Monitor Well	Southern Tract LL-7
Arsenic	-	-	-	-	-	-
Barium	58	77	34-69	36-72	56	96
Chromium	-	5	-	0-6.2	43	12
Lead	6J	-	0-4J	0-10J	7.2	-
Manganese	240	270	36-240	72-270	300	2,200
Iron	4,300	1,800	100-1,100	2,000-4,800	5,200	3,700

- Not detected
J Estimated value.

(397 feet amsl) when all four ponds were separated. If this hypothesis were true, the ponds would be expected to discharge to the groundwater. However, the permeability of the underlying materials would have to be low or the ponds would not contain water year-round.

To further investigate this hypothesis, the range of concentrations in the surface water in the pond was compared to the shallow groundwater concentrations found in LL-7. As can be seen in Table 5-17, manganese was higher in the groundwater than in the pond (2,200 and 270 ug/l, respectively) and lead was detected in the pond and not in the groundwater. A second comparison of the concentrations in the surface water in the ponds to the upgradient shallow groundwater was made based on the possibility that LL-7 might be affected by landfill leachate and not be characteristic. This second comparison suggests that the upgradient chromium concentration (43 ug/l) is not similar to the chromium concentrations in the water in the ponds (0 to 6.2 ug/l). Therefore, there is no evidence that groundwater is discharging to the ponds in the Southern Tract.

The samples from the Ohio River were collected a few feet from the bank and were intended to be within the mixing zone if leachate or shallow groundwater were being discharged to the Ohio River near the shore. These samples were paired with well point locations (shallow groundwater at the river bank) for a potential comparison of cause and effect. The concentrations found in the paired shallow groundwater and the near-shore Ohio River samples are shown in Table 5-18. The sample analyses of the Ohio River at RM 616.6, provided by Louisville Gas and Electric (LG&E) and STORET, are the range of previous sample concentrations and were not collected during the RI. The Ohio River data collected during the RI can not be compared to the results of the Ohio River samples furnished by LG&E, but they can be used to suggest the ranges of concentrations found in the Ohio River over time. The concentrations presented in the table can only be used to suggest that there is no evidence that the discharge of shallow groundwater from the Lees Lane Landfill Site is having an effect on the quality of the Ohio River near the site.

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TABLE 5-18
COMPARISON BY TRACT OF SELECTED CONSTITUENTS SHALLOW GROUNDWATER AND NEAR-SHORE OHIO RIVER LEES LANE LANDFILL SITE JEFFERSON COUNTY, KENTUCKY

	Northern Tract		Central Tract		Southern Tract		
Parameter in ug/l	Groundwater WP-1	Ohio River OR-1	Groundwater WP-4	Ohio River OR-2	Groundwater WP-6	Ohio River OR-3	Ohio River RM 616.6
Arsenic	-	-	20J	-	-	-	1-13*
Barium	210	-	400	-	220	-	60-62**
Chromium	29	-	29	-	33	-	10-60*
Lead	83	-	17	-	18	-	1-150*
Manganese	1,400	83	2,200	75	940	120	562*
Iron	25,000	1,100	57,000	1,100	34,000	1,800	600-2,400*

- Not detected.
J Estimated value.
* Sample data supplied by USEPA, STORET system (see Table 5-2).
** Sample data supplied by Louisville Gas and Electric Company, Cane Run Plant (see Table 5-2).

5.5.3 Migration Pathways

The onsite surface migration pathways for surface water and sediment appear to be through overland flow to slightly lower lying areas in the Northern and Central Tracts (as evidenced by small areas of standing water) and to the large depression in the Southern Tract. However, the permeability of the cover material suggests that most rainfall infiltrates the landfill and that overland flow and the associated erosion and onsite transport of surface soils is only likely during heavy rainstorms. As discussed in the previous section, there is no evidence of a hydraulic connection between the pond in the Southern Tract and groundwater. The offsite migration pathways for surface water and soils must be assumed to be to the Ohio River based on site topography.

5.5.4 Potential Public Health Effects

Since site access is unrestricted, the potential public health effects associated with onsite surface water, sediment, or surface soils is through direct contact with these materials by persons using the site for recreational purposes.

5.6 Surface Water, Sediment and Soil Summary

The surface investigation of this RI included the collection and analysis of water and sediment samples from four onsite areas of surface water. Two of these areas were small standing water bodies in the Northern and Central Tracts. A marshy area and a depression containing one to four ponds located in the Southern Tract were also sampled. There were no obvious drainageways in between these four areas, although, based on existing topography, a large portion of the Southern Tract appears to drain into the ponds in this tract. The source of the water in these onsite water bodies is derived from rainfall.

The surface soil was also sampled to locate "hot-spots" of contamination and determine if isolated portions of the landfill would need special remedial measures to protect the public from direct contact with contaminated soils. Except for the runoff in the Southern Tract toward the large depression, transport of surface soils within the landfill boundaries is probably minimal and occurs during heavy rainstorms.

Flooding of the Ohio River may effect the landfill through erosion of the surface material and subsequent transport into the Ohio River, as well as erosion of the western bank of the landfill. Flood levels below the designated 50-year flood level would inundate only a small part of the site, mostly along the river terraces. The 50-year flood level would cover portions of the Northern and Southern Tracts. In the Southern Tract, much of the floodwaters would collect in the large depression in the southeast corner. The entire site would be inundated by the designated 500-year flood level. The flood protection levee was designed to protect the upland property from a flood of this magnitude. The levee also prevents upland runoff from flowing over the landfill. Most onsite runoff flows westward into the Ohio River, while a small portion may flow into the mouth of the Mill Creek Cutoff immediately before it empties into the Ohio River.

The concentrations found in samples of the onsite soils and sediments were similar to those found in the background sample suggesting that the landfill cover material was derived from nearby soils. Only two soil samples showed elevated concentrations of contaminants and these two samples were probably affected by localized areas of surface waste disposal.

The onsite surface water samples appear to contain similar concentrations from tract to tract. None of the contaminants were found at elevated levels. Surface water samples collected from the Ohio River were compared to groundwater samples collected from nearby shallow well points. The results do not suggest that the discharge of shallow groundwater from the landfill is affecting the nearshore water quality in the Ohio River.

6.0 AIR/GAS MIGRATION INVESTIGATION

The production of organic gases in landfills is the result of decomposition of wastes. The air/gas migration investigation focused on the potential gas migration from the site above and below the landfill and surrounding surface. The investigation was accomplished through the review of previous studies performed at the site and the inspection conducted during the RI.

6.1 Landfill Gas Production

Sanitary landfills usually receive large quantities of organic wastes. When compacted and covered with soil, these wastes will decompose anaerobically. The gaseous byproducts of anaerobic decomposition are predominantly methane and carbon dioxide. Typical concentrations of gases inside a landfill range from 50 to 65 percent methane, and from 35 to 50 percent carbon dioxide. The balance of the gas volume includes small concentrations of atmospheric gases (nitrogen and oxygen) and other decomposition gases.

Landfill gases, when generated, create positive pressures inside the landfill. The gases then tend to move away from the landfill as a result of the convective pressure forces as well as through diffusion. The greater the convective force the greater the lateral movement of these gases. A rapidly rising water table, as is often seen at the site, can accelerate the migration of gas by reducing the volume of void spaces in the unsaturated zone. Migrating gases usually take the path of least resistance; this may be vertically through the top of the fill as well as laterally. However, temporary site conditions (such as frozen or saturated cover) found at any landfill may serve to temporarily restrict vertical movement; other permanent conditions (such as tight soils above and/or adjacent to the fill) may further restrict vertical movement. The end effect of such conditions is increased lateral movement of landfill gases.

The generation and migration of landfill gases from the Lees Lane Landfill is expected since the site reportedly received large quantities of organic wastes. Since the gases will move towards the point of least resistance, the potential presence of tighter, less permeable soils near the ground surface at Riverside

Gardens may act as an impedence to vertical gas migration. However, discontinuities in the soil, natural or man-made, may allow movement of the gases to the surface.

6.2 Landfill Gas Investigations Before 1980

The potential threat posed by the gases produced by the landfill was not noticed until 1975. Several investigations were performed which lead to the installation of a gas collection and control system in 1980. The system was installed between the landfill and Riverside Gardens, a nearby residential area.

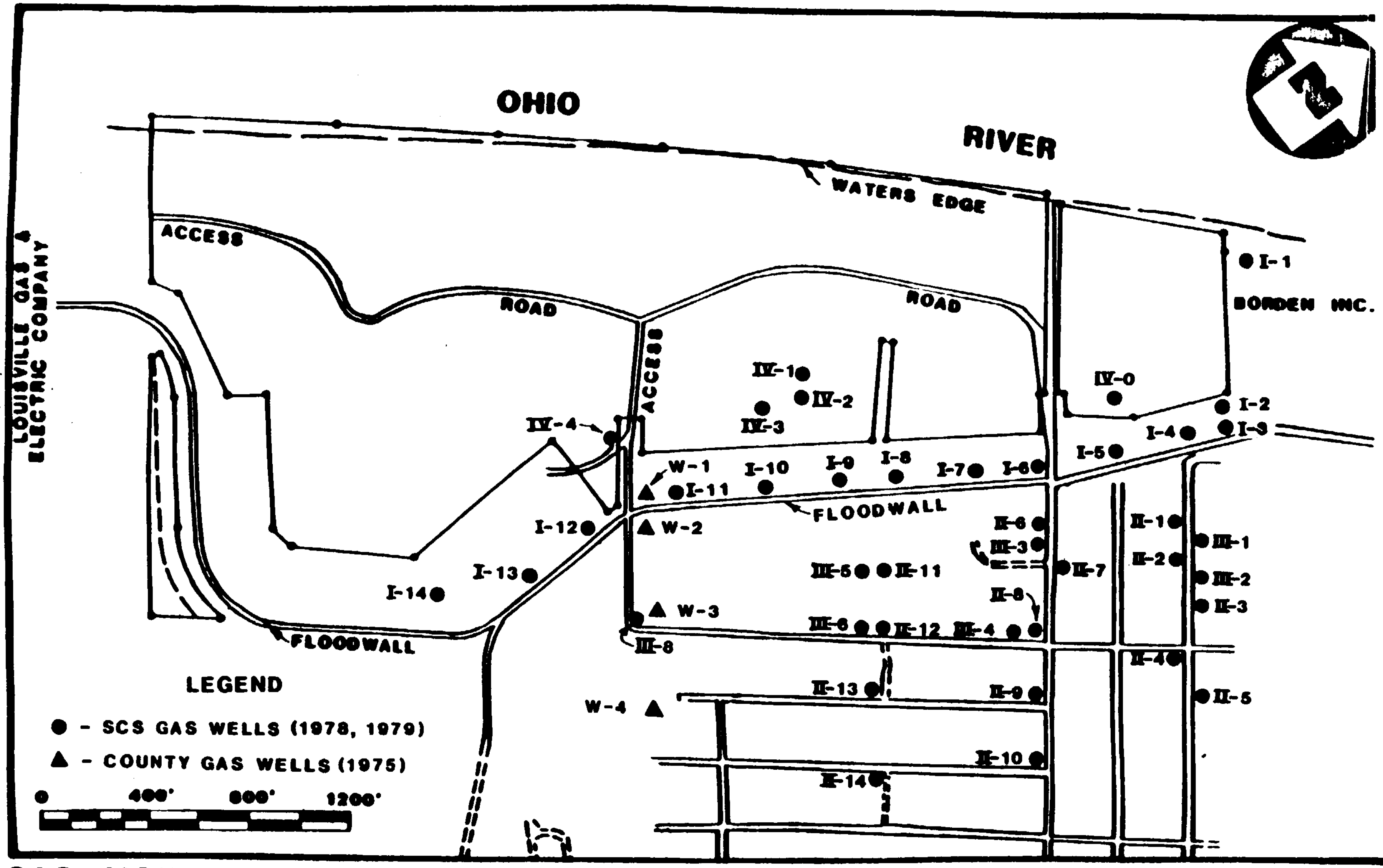
6.2.1 Initial Investigations (1975)

On March 12, 1975 a plumber was called to a house on Putman Avenue to check on a hot water heater burner. During this inspection, a gas leak was detected and followed to a recently installed dry well. The local fire department was notified and explosive concentrations of methane were discovered at the well. The Jefferson County Department of Public Health (DPH) was subsequently notified.

On March 19, 1975 seven families living along Putman Avenue were evacuated at a cost to Jefferson County of over $150,000.

On March 24, 1975, an official request to assist in establishing a continuous monitor network and continuing analysis of the samples collected was made by the Air Pollution Control District of Jefferson County to EPA Region IV, Surveillance and Analysis Division. On March 26, 1975, this network was installed and sampling began at midnight.

This network consisted of four test wells (W-1 through W-4) installed in an east-west line, perpendicular to Putman Avenue and the landfill boundary, to monitor the quantity and movement of landfill gases (see Figure 6-1). The wells were installed to an approximate depth below land surface of 30 feet with the farthest well located 986 feet from the landfill boundary.



GAS MONITOR WELLS
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

FIGURE 6-1

NUS CORPORATION
A Halliburton Company

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During this study, grab and composite samples were collected from several areas around the landfill and around houses on Putman Avenue. All samples were analyzed for explosive gases, including methane. Some of the samples were analyzed for other organic gases including vinyl chloride and benzene. Methane was detected in nonquantifiable levels in the ambient air samples. However, since methane is expected to be present in ambient air where there is vegetation, industry, or automobiles, the presence of methane is considered normal. No other organic compounds were detected in the ambient samples. Methane (see Table 6-1) was detected in quantifiable levels (between 0 and 85% volume in air) within the test wells. Five to fifteen percent methane in air is considered the explosive range. Table 6-2 indicates the results of the analyses of a composite sample collected from one of the test wells which contained several other organic gases.

In April 1975, using previously compiled data, the Kentucky Natural Resources and Environmental Protection Cabinet (NREPC) filed a lawsuit that closed the landfill. As a result of the Health Department's findings, all construction requiring excavation was prohibited within 860 feet of the landfill. Also, any construction proposed within 1,500 feet of the landfill was required to be preceeded by a gas test. At that time there were 56 homes within 860 feet of the landfill and 86 homes within the 1500-foot limit.

The Jefferson County Planning Commission completed a small area study of Riverside Gardens in October 1977. The report recommended that the County Fiscal Court fund an engineering study of the gas problem. In March 1978, the Fiscal Court authorized funding to conduct a gas migration study. On May 12, 1978, the Housing Authority and Community Development Agency acting as agent for Fiscal Court entered into contract with Stearns, Conrad and Schmidt, Consulting Engineers to perform the study.

6.2.2 Stearns, Conrad, and Schmidt Investigation (1978)

Monitoring efforts began by Stearns, Conrad, and Schmidt Engineers, Inc. (SCS) immediately after funding was authorized. Fourteen monitor wells were installed by mid - June 1978. Most of these wells were placed in the floodwall right-of-way, 250 feet from the landfill. Seven were drilled to an average depth of 55 feet, at

TABLE 6-1
SUMMARY OF 1975 HEALTH DEPARTMENT METHANE MONITORING
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Probe No.	Distance From Landfill (ft)	Probe Depth (ft)	Methane Readings (% Volume in Air)			No. of Times Monitored
			Mean	Min.	Max.	
W-1	175	30*	47.7	0	85	64
W-2	271	30*	45.6	0	80	64
W-3	714	30*	30.8	0	65	64
W-4	986	30*	0	0	0	64

* Approximate

Source: SCS, 1979.

TABLE 6-2
EXOTIC GAS ANALYSIS (MARCH 1975)
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

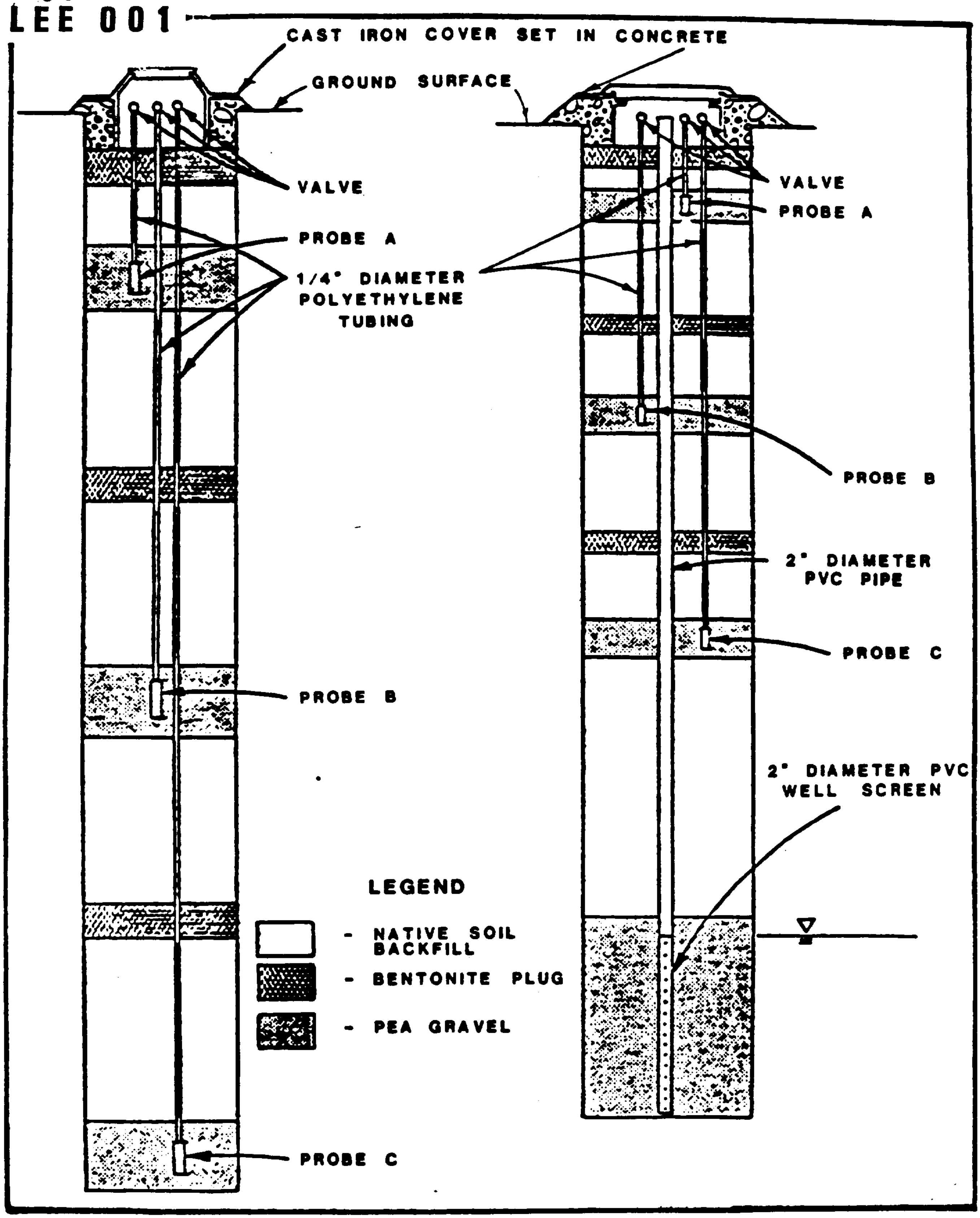
Compound	Mean Concentration (ppm)	Number of Analyses
1. Benzene	15	1
2. Butene	30	1
3. Chloroethane	1	1
4. Cyclohexane	5	1
5. Dichloroethane	22.5	1
6. Dichloroethene	40	1
7. Ethylbenzene	27.5	1
8. Heptane	15	1
9. Heptene	20	1
10. Hexane	15	1
11. Isobutane	10	1
12. Methylcyclopentane	5	1
13. Toluene	175	1
14. Vinyl Chloride	6.7	20
15. Xylene	45	1
16. 1,3 Butadiene	3	1

Source: SCS, 1979.

least 5 feet below the water table so that groundwater levels could be monitored. The other seven wells averaged 30 feet in depth and did not intercept groundwater. As shown in Figure 6-2 each well consisted of three separate gas monitoring probes at evenly spaced depths. Each probe was packed in gravel to allow gas to collect in its vicinity; a clay plug was installed between alternate probes and between the top probe and the surface to prevent vertical movement of gas in the backfill material. These 14 wells were part of the Phase I program and are identified as Wells I-1 through I-14 in Figure 6-1. The well headspace was monitored for methane levels and the results are presented in Table 6-3. Methane levels between 0 and 84% volume in air were documented.

After two months of monitoring the well headspace, the recorded high levels of methane prompted the County to expand the investigation into the Riverside Gardens subdivision. In September 1978, fourteen additional wells were installed along three radial lines from the landfill. The wells were installed to a depth of 6 feet and are identified as wells II-1 through II-14 in Figure 6-1. The wells were monitored twice monthly to coincide with the procedure adopted for the Phase I wells. Methane readings from these wells were negative on all occasions. To further investigate the migration of the landfill gases, Phase III monitoring was devised whereby eight deep wells were installed throughout Riverside Gardens in much the same areas as Phase II wells. These wells were installed in late October 1978 and are identified as Wells III-1 through III-8 in Figure 6-1. Locations varied from 510 up to 900 feet from the landfill. Wells were drilled to groundwater, averaging 55 feet in depth. Three (and in one case, four) gas probes were installed in each well with gravel backfill and clay plugs appropriately placed. Field monitoring for methane began immediately and proceeded twice monthly along with Phase I and Phase II wells. Results are presented in Table 6-4.

The discrepancy between methane results for Phase II and Phase III wells was explained as a result of detailed soil boring logs compiled during placement of Phase III wells. Soil profiles at most Phase III wells were found to be similar consisting of 12 feet of clayey silt at the surface, followed by ever higher permeability soils (e.g., fine to medium sand to 35 feet and medium to coarse sand and gravel to 55 feet). Since methane can move more readily through loose, permeable soils than tight ones, it was more likely to be detected in the sand and



GENERAL GAS WELL CONSTRUCTION
SCS PHASE I WELLS
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

FIGURE 6-2

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TABLE 6-3
SUMMARY OF PHASE I METHANE MONITORING
7/20/78 to 12/21/78
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Probe No.	Distance From Landfill (ft)	Probe Depth (ft)	Methane Readings (% Volume in Air)			No. of Times Monitored
			Mean	Min.	Max.	
I-1A	125	8	39.4	0	68	10
B	125	15	44.2	6	67	10
C	125	24	42.1	8	69	10
I-2A	25	12	64.6	36	83	11
B	25	25	63.4	28	84	11
C	25	38	64.0	24	82	11
I-3A	250	9	56.2	20	76	10
B	350	17	57.7	38	72	10
C	250	23	60.1	40	72	11
I-4A	250	9	52.8	0	68	11
B	250	23	58.9	30	76	11
C	250	35	60.6	32	76	11
I-5A	250	7	25.5	0	70	11
B	250	15	41.8	0	67	11
C	250	22	52.8	39	68	11
I-6A	250	9	58.5	0	78	11
B	250	19	60.0	32	70	10
C	250	39	56.4	6	73	11
I-7A	250	9	51.5	0	68	11
B	250	14	55.6	18	72	11
C	250	25	58.5	44	74	11
I-8A	250	12	35.1	0	72	11
B	250	22	39.0	6	74	11
C	250	42	37.5	8	72	11
I-9A	250	6	25.9	0	72	11
B	250	15	35.3	0	68	11
C	250	28	36.7	18	72	11
I-10A	250	12	54.9	22	70	11
B	250	22	47.7	0	71	11
C	250	42	55.1	30	69	11
I-11A	250	8	53.0	0	66	11
B	250	20	54.4	20	69	11
C	250	28	53.4	22	68	11
I-12A	150	12	66.4	48	80	11
B	150	22	67.0	48	79	11
C	150	42	65.5	52	79	11
I-13A	475	8	41.6	0	76	10
B	475	17	62.1	55	72	10
C	475	25	61.2	53	74	10
I-14A	75	15	16.6	0	79	11
B	75	24	15.1	0	68	11
C	75	35	19.9	0	72	11

Source: SCS, 1979.

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TABLE 6-4
SUMMARY OF PHASE III METHANE MONITORING
10/25/78 to 12/21/78
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Probe No.	Distance From Landfill (ft)	Probe Depth (ft)	Methane Readings (% Volume in Air)			No. of Times Monitored
			Mean	Min.	Max.	
III-1 A	510	12	35.3	9	51	4
B	510	24	36.5	21	51	4
C	510	46	32.0	0	46	4
III-2 A	690	14	24.0	12	32	4
B	690	25	31.8	8	32	4
C	690	40	21.0	8	31	4
III-3 A	530	9	47.0	32	58	4
B	530	15	42.5	30	54	4
C	530	23	35.0	5	56	4
D	530	43	36.8	5	56	4
III-4 A	900	11	10.8	0	22	4
B	900	23	17.3	0	26	4
C	900	44	10.0	0	17	4
III-5 A	590	11	0	0	0	4
B	590	28	0	0	0	4
C	590	39	0	0	0	4
III-6 A	800	9	3.3	0	8	4
B	800	28	2.5	1	5	4
C	800	36	2.0	1	3	4
III-7 A	360	9	56.8	36	66	4
B	360	20	55.8	28	67	4
C	360	40	51.3	14	66	4
III-8 A	500	11	20.3	14	26	3
B	500	25	21.0	7	28	3
C	500	40	12.0	5	16	3

Source: SCS, 1979.

gravel below the 12-foot depths. Phase II wells were only 6 feet deep and did not penetrate the clayey silt layer at the top of the soil profile.

Samples were collected in December 1978 from the well headspace of several Phase I and Phase III wells and analyzed for other organic gases. The gases analyzed for were chosen based on the results of the 1975 study supervised by Jefferson County. The results are presented in Table 6-5.

6.2.3 National Enforcement Investigation Center Investigations (1978-1979)

The National Enforcement Investigation Center (NEIC) became involved in a study of Lees Lane Landfill in December of 1978 at the request of Region IV EPA. At that time it was believed that a substantial hazard existed in the Riverside Garden residential area next to the landfill. Explosive levels of methane gas had been reported in the neighborhood during 1975 and were believed to have originated from the landfill. The possibility existed that, even though the landfill had been closed since 1975, widespread and dangerous concentrations of methane gas might be present in the homes.

On December 6, 1978, EPA Region IV Enforcement Division requested NEIC to:

1. Determine the level of methane or other combustible gases in houses in the Riverside Gardens residential area near the Lees Lane Landfill;

2. Ascertain the level of methane or other combustible gases being emitted from existing monitoring wells; and

3. Verify, if possible, the source of the gases.

The study was conducted in two phases. During the first phase conducted December 14 to 16 NEIC personnel measured the concentration of methane/combustible hydrocarbons the basements, crawl spaces, and living areas of 28 homes adjacent to the landfill. The levels of methane and other combustible gases in these homes were well below the lower explosive limit (LEL) of methane, which

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TABLE 6-5
EXOTIC GAS ANALYSIS (DECEMBER 1978)
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Compound	Concentration (ppm)					
	Probe I-3B	Probe I-4B	Probe I-5B	Probe I-10B	Probe I-11B	Probe I-12B
1. Benzene	7.5	7.5	0.4	7.8	TR	29.5
2. Butane/Butene	11.6	17.7	12.8	9.5	NF	TR
3. Chlorobutene	2.1	2.6	TR	2.5	14.7	TR
4. Cyclohexane	NF	NF	NF	NF	NF	NF
5. Dichlorodifluoro-methane (freon)	NF	NF	NF	NF	NF	NF
6. Dichloroethane	6.1	10.7	0.8	5.8	22.7	8.5
7. Dimethylcyclohexane	NF	NF	NF	NF	NF	NF
8. Ethylbenzene	10.8	12.3	8.6	12.8	10.8	16.6
9. Heptane	NF	NF	NF	NF	TR	TR
10. Heptene	NF	NF	NF	NF	NF	NF
11. Hexane	4.9	8.6	NF	4.6	36.8	6.7
12. Isobutane	NF	NF	11.0	NF	NF	NF
13. Methylcyclopentane	NF	NF	NF	NF	NF	NF
14. Toluene	12.6	15.6	10.1	11.3	23.6	TR
15. Vinyl Chloride	22.6	21.3	24.1	17.9	122.6	46.0
16. Xylene	10.7	9.8	nf	7.9	NF	NF
Number of other peaks	4	4	7	3	6	5
Highest concentration found in other peaks (ppm)	38	45	45	35	44	86

NF - Not Found
TR - Trace (Non-quantifiable)

Source: SCS, 1979.

is 5% volume in air. The Phase II study was conducted in January 1979. The area studied during Phase II extended approximately 1,000 feet into the Riverside Gardens neighborhood northeast of the floodwall. The well sites sampled during this phase were selected based on proximity to the houses at 4425 Wilmoth Avenue and 6715 Putman Street and the landfill, since the highest levels of combustible gases, 0.6 and 0.2% respectively, were found in these two houses during the Phase I study. Wells W-1 through W-4, I-3, I-4, I-8 and I-12 were sampled (Figure 6-1). Wells W-2 and I-12 were next to the landfill and near the house on Putman Street. Well W-3 was farther from the landfill but very close to the house on Wilmoth Avenue. Similarly, wells I-3, and I-4 were close to and between the landfill and the house on Wilmoth Avenue. Well I-8 is located along the floodwall midway between the wells sampled at the north and south ends of the area. It was sampled to determine if the gas composition along the flood wall was consistent.

High concentrations of methane/combustible gas were present in a number of test wells sampled during this portion of the investigation. Methane levels of 27 to 79% by volume in air were measured in various test wells using a methane meter (see Table 6-6). Flow rates from the test wells when opened were low. Based upon the timed filling of a sampling bag, rates at several wells were found to be at or below 2 liters per minute.

NEIC found that there was a great similarity in concentration and composition of the various gaseous components in the well samples taken during this study. These components were present in greater concentrations nearest the south end of the Southern Tract, which was the most recently closed section. Component concentrations decreased in an easterly direction, away from the landfill. Comparisons indicated the composition of landfill gases was dissimilar to the commercial natural gas supply in the area.

Explosive levels (5 to 15% by volume) of methane gas did not exist in any of the 28 homes sampled during this portion of the investigation. A methane meter was used to check basements, crawl space, drains and various other areas in houses for the presence of methane. Concentrations of methane above 0.1% volume in air were not found.

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TABLE 6-6
MSA GASCOPE MEASUREMENTS (JANUARY 1979)
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Time	Location	Methane Readings (% Volume Air)
1542	Existing Well #1	42
1547	Existing Well #2	76
1553	Existing Well #3	42
1336	Well I-12, level 1	56
	Well I-12, level 2	72
	Well I-12, level 3	79
1531	Well I-4, level 1	44
	Well I-4, level 2	65
	Well I-4, level 3	70
1721	Well I-3, level 1	66
	Well I-3, level 2	76
	Well I-3, level 3	75
1112	Exisitng Well #1	40
1134	Existing Well #2	75
1210	Existing Well #3	38
1241	Well I-8, level 1	27
	Well I-8, level 2	31
	Well I-8, level 3	30

Source: NEIC, 1979.

A number of samples collected at various locations next to the landfill and in the residential area were analyzed for other organic gases, similar to the EPA (1975) and SCS (1978) studies. Samples of emissions were collected on charcoal tubes and analyzed by gas chomatography/mass spectrometry (GC/MS). These analyses showed the presence of low levels of 13 organic compounds including vinyl chloride (a carcinogen) in concentrations up to 14 parts per million by volume (ppmv,) and benzene (a carcinogen) in concentrations up to 7 ppmv (see Table 6-7).

A correlation between test well gases and air samples collected in houses could not be made from analyses of the samples collected during study. Air samples collected on charcoal tubes were analyzed by GC/MS and showed the presence of n-hexane and dichlorodifluoromethane, two of the components of the test well gases. Other characterisitic components of test well gases potentially present in homes were either too low to measure or absent.

6.3 Gas Collection System (1979-1980)

In early 1979 the gas migration hazards had been identified and work proceeded on designating an appropriate control concept. A contract for this service, was awarded to SCS Engineers on March 28, 1979.

In mid-April 1979 SCS directed the installation of five additonal observation wells labeled IV-0 through IV-4. These wells were placed in the refuse on a line parallel to and 75 to 150 feet inside the landfill property boundary.

Well IV-2 was constructed as a small-scale extraction well to be used for a pumping test (SCS, 1979). The pumping test was initiated on May 24, 1979. The results of this test suggested:

- 25 cubic feet per minute was sufficient to generate a pressure drop of 0.10 inches of water 100 feet away and 0.06 inches of water 30 feet away

- Increasing the extraction flow rate did not generate proportionate increases in negative pressure

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TABLE 6-7
EXOTIC GAS ANALYSIS (JANUARY 1979)
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Name	I-12	W-2	W-2	W-2	W-3	I-8	I-4	I-3	Wilmoth	Wilmoth	Wilmoth	Putnam
Vinyl Chloride Monomer	11	12[1]	11	14	7.5	5	3.6	5	ND	ND	ND	ND
Dichlorofluoromethane	-	-	-	-	-	-	-	-	ND	ND	-	-
Butene	-	-	-	-	-	-	-	-	ND	ND	ND	ND
n-hexane	11	28	27	26[1]	ND[1]	2	1.9	2.9[1]	0.07	0.07	0.04	ND
Ethyl Chloride	-	-	-	-	-	-	-	ND	ND	ND	ND	ND
n-Heptane	1.9	2.8	2.8	2.6[1]	ND	ND	ND	ND	ND	ND	ND	ND
Methylcyclohexane	9.3	11	10	10	ND	0.22	1.2	2.3	ND	ND	ND	ND
1,1-Dichloroethane	ND	45	42	40[1]	ND	ND	ND	ND	ND	ND	ND	ND
Benzene	0.36	6.7	6.4	6[1]	0.2[1]	0.55	0.36	0.7[1]	ND	ND	ND	ND
1-Ethenyl-4-Cyclohexene	21	33	31	28[1]	0.4	0.4	12	20[1]	ND	ND	ND	ND
1,1-Dichloroethene	-	-	-	-	-	ND	-	ND	ND	ND	ND	ND
1,2-Dichloroethane	ND	18	17	16	ND	ND	1.1	ND	ND	ND	ND	ND
p-Xylene	1.3	5.5	5	4.4	ND	ND	0.26	0.56	ND	ND	ND	ND

1 Verified by GC/MS.
- Identified as being present but amount could not be determined due to the unavailability of standard reference materials.
ND Not detected.
Note: Based upon 45 liter volume, reported in ppmv (for wells, 1 liter samples were collected which would make this detection limit 45 times higher).

Source: NEIC, 1979.

Most of the methane readings shown in Table 6-8 are as would be expected for in-refuse probes. Exceptions to this were the zero readings for Probes IV-0B, IV-1B, and IV-3B. The negative reading at Probe IV-0B is due to this probe being below the water level and, therefore, saturated. While Probes IV-1B and IV-3B are above the water level by several feet, their probe tips were believed saturated and unable to draw gas samples.

In December 1979, SCS collected samples from the Phase IV wells for analyses of organic compounds other than methane. Most of the compounds were detected in lower quantities than in the previous SCS study. The results are presented in Table 6-9.

Based on the pertinent results from the previously collected data, an elaborate gas collection system consisting of 31 collection wells and a blower was installed around the landfill boundary bordering Riverside Gardens (see Figure 6-3). The design criteria established for the system were:

1. Well depth = 5 feet below the bottom of the refuse.
2. Well boring diameter = 24 inches
3. Well pipe diameter = 4 inches
4. Well spacing = 150 feet
5. Flow rate = 25 cubic feet per minute per well.
6. Pressure = -2.5 inches of water at each well head.

The system, according to the SCS Engineers' report, "Design of the Existing Gas Collection System", consists of 31 extraction wells spaced approximately 75 feet apart; 4-inch diameter connective headers; moisture traps between every two wells; blower house with blower and motor; and an audible alarm system that engages whenever the differential pressure across the blower drops below 10-inches of water. A gas burner was included in the original system design and was shown on the completed as-built drawings. Through contact with SCS Engineers who designed the system, it was learned that the gas burner was not installed.

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TABLE 6-8
CONSTRUCTION AND MONITORING OF IN-REFUSE WELLS
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Well No.	Probe No.	Drilled Depth*	Refuse Depth*	Well Pt. Depth*	Probe Depth*	Water Level* 5/3/79	Water Level* 5/25/79	Percent Methane in Air 5/3/79
IV-0		41.5	37.0	37.0	-	22.6	30.8	-
	A	-	-	-	8.0	-	-	42
	B	-	-	-	26.0	-	-	0
IV-1		36.5	29.0	35.0	-	33.3	33.8	-
	A	-	-	-	8.0	-	-	45
	B	-	-	-	18.0	-	-	0
IV-2		25.5	19.0	22.0	-	20.8	(Dry)	-
	A	-	-	-	5.0	-	-	27
IV-3		30.5	20.0	29.0	-	23.3	24.2	-
	A	-	-	-	12.0	-	-	23
	B	-	-	-	20.0	-	-	0
IV-4		30.5	25.0	29.0	-	30.2	(Dry)	-
	A	-	-	-	12.0	-	-	58
	B	-	-	-	22.0	-	-	72

* In feet below ground surface.

Source: SCS, 1979.

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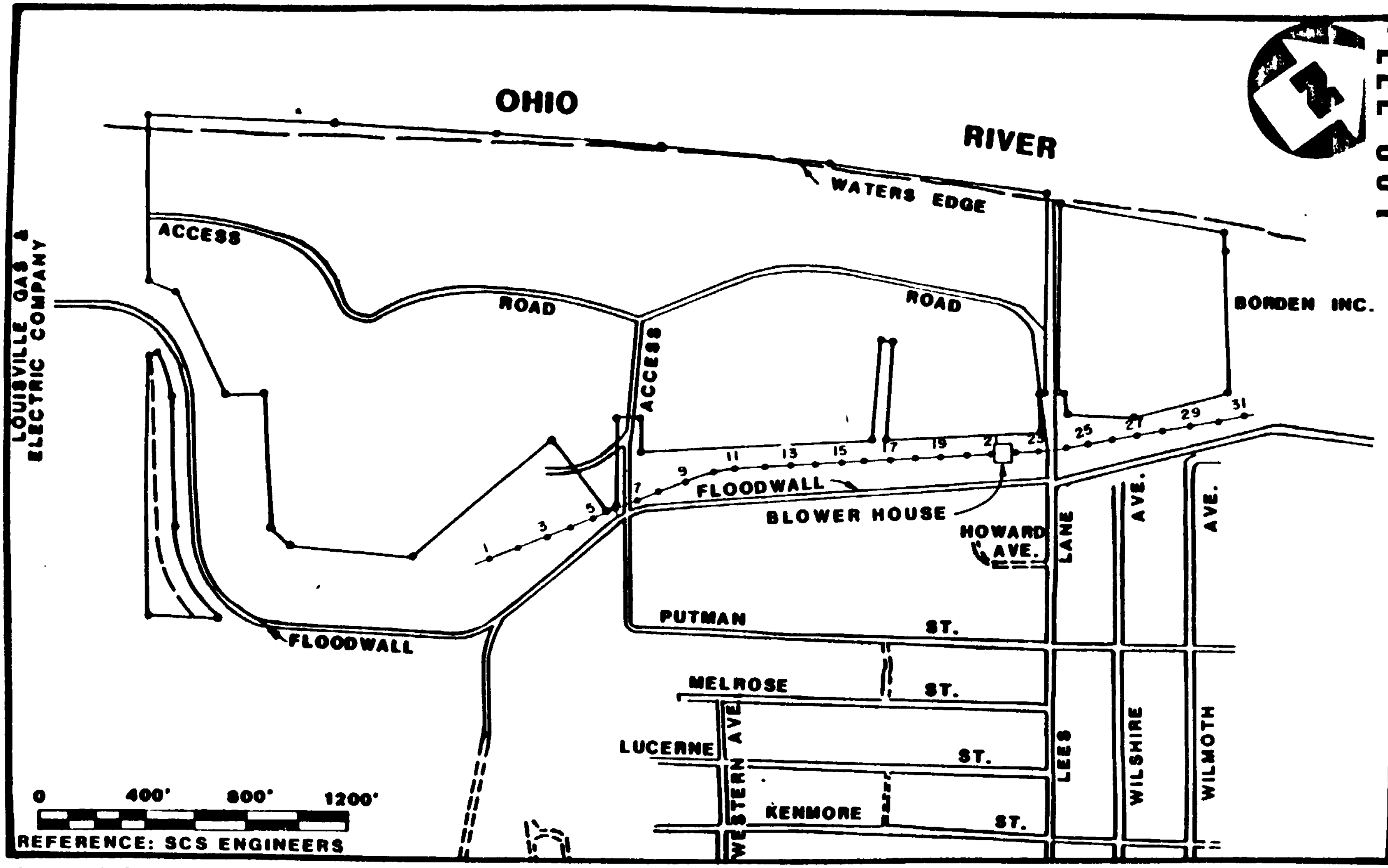
TABLE 6-9
EXOTIC GAS ANALYSIS (DECEMBER 1979)
LEES LANE LANDFILL
JEFFERSON COUNTY, KENTUCKY

Compound	Concentration (ppm) Mean	Min.	Max.	Number of Analyses
Benzene	6.0	0	45.8	8
Butane/Butene	0.3	0	1.8	8
Chlorobutene	1.4	0	10.8	8
Cyclohexane	3.1	5.6	19	8
Dichlorodiflouro-methane (freon)	10.9	0	25.7	8
Dichloroethane	1.9	0	14.9	8
Dimethylcyclohexane	-	-	-	0
Ethylbenzene	0.3	0	2.0	8
Ethylene	2.2	0	9.2	8
Heptane	-	-	-	0
Heptene	-	-	-	0
Hexane	[illegible].8	0	6.7	9
Isobutane	1.6	0	10.8	8
Methylcyclopentane	-	-	-	0
Toluene	0.8	0.7	5.7	8
Vinyl Chloride	37.0	0	188	9
Xylene	-	-	-	0

Source: SCS, 1979



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GAS COLLECTION SYSTEM
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

FIGURE 6-3

NUS CORPORATION
A Halliburton Company

6.4 Landfill Gas Investigations After 1980

Several air/gas studies were performed after installation of the gas collection system. Sampling investigations were performed by Jefferson County and IT Corporation. IT Corporation was tasked by the EPA to inspect the site for gaseous contaminants and to determine the operational efficiency of the gas collection system.

6.4.1 County Monitoring (1980 - 1984)

Jefferson County has monitored, monthly, the well headspace in wells I-2, I-4, I-6, I-8, I-10, I-12, and I-14, as well as all of Phase III wells since September 1980. Until April 1984, methane levels were recorded as being non-detectable, quantified at 0% volume in air. In April and in May 1984 methane in the well headspace in I-12 was recorded at 40 to 60% volume in air at the top of the well and 60 to 90% volume in air at the bottom of the well. Field personnel noted on these two periods that the blower pumps were inoperable. The headspace in all of the other wells sampled showed no quantifiable methane levels during this period.

6.4.2 IT Corporation Investigation (1984)

On September 13, 1984, IT Corporation performed an inspection at the site, which included a survey of the site using an explosimeter and an HNU (IT Corporation, 1984a). All readings indicated nondetectable levels of explosive or other types of organic gases in the air above the landfill. One well headspace sample collected from an extraction well in the Central Tract gave an HNU reading of 2 ppm while all other headspace samples showed nondetectable levels of explosive or other organic gases. IT also collected three grab air samples from the headspace in wells within the gas collection system for further analyses. Two of the samples contained several organic compounds verified through GC/MS analyses. The results, presented on Table 6-10, were not quantified.

In November 1984, IT returned to the site to inspect the gas collection system and to evaluate its effectiveness in controlling the landfill gas migration. IT reported that because of lack of maintenance, subsided wells and moisture traps, and

TABLE 6-10
CONSTITUENTS OF GAS SAMPLES COLLECTED BY
IT CORPORATION (SEPTEMBER 1984)
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Chloroacetylene

Dichlorodifluoromethane

Chloroethane

Dichlorotetrafluoroethane

Butene

C_2H_{14} (possibly methyl cyclohexane)

C_6H_{12} hydrocarbon

C_7H_{16} hydrocarbon

C_8H_{16}(possibly dimethylcyclohexa)

$C_{10}H_{22}$ hydrocarbon

C_9H_{18} hydrocarbon

Source: Clayton Environmental Consultants, Inc., 1984.

vandalism, the gas collection and control system was apparently not operating at design capacity. Extraction wells 1 through 13 and 27 through 31 were inoperable yielding a system operating efficiency of less than 50%. From preliminary testing, however, IT concluded that the system design criteria had either been met or exceeded.

Four extraction wells, identified as inoperational by IT field personnel, were used for the gas monitoring program. The wells selected for the monitoring program were located throughout the entire site and are identified as:

Extraction Well No. 3 - Southern Tract
Extraction Well No. 7- Central Tract
Extraction Well No. 9 - Central Tract
Extraction Well No. 31 - Northern Tract

Along with the samples collected from the wells listed above, ambient samples were collected from an area near the pumphouse door. To evaluate the effectiveness of the system, comparable samples were collected when the gas collection system was operational (blower on) and when the system was not operational (blower off overnight prior to sample collection).

6.4.2.1 Methane Analyses

Methane levels were determined using an MSA Gasscope Model 625, combination explosimeter and methane-meter. As shown in Table 6-11, methane levels of 46 to 48% volume in air were recorded in well number 3, when the blower was on and 38% volume in air when the blower was turned off. Slight changes in methane levels were noticed in wells 7 and 9 during operation versus non-operation of the blower (see Table 6-11). Septic odors, noticed by IT in all three wells, were unaffected by blower operation. No detectable methane or odors were found in Well 31.

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TABLE 6-11
METHANE MONITORING (SEPTEMBER, 1984)
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

		Methane Concentration (% By Volume)	
Extraction Well Number	Location	Blower Off	Blower On
3	Southern Tract	38(1)	46-48(2)
7	Central Tract	34	30
9	Central Tract	4	10-12(2)
31	Northern Tract	ND	ND

* Concentrations determined at two feet depth in 1-inch pipe (sample port) using MSA Gasscope Model 62S, calibrated for methane.

(1) Determined during sampling operations.

(2) Duplicate readings.

Source: IT Corporation, 1984b.

6.4.2.2 Additional Analyses

The extraction wells used for methane monitoring were also used for organic vapor monitoring. The exhaust system evaluation consisted of air quality monitoring downwind of the pumphouse. The monitoring program involved the collection of known volumes of air samples using a sampling pump and charcoal adsorption tubes followed by gas liquid chromatographic analysis. Portable battery operated air sampling pumps were used. The samples were analyzed for six indicated compounds selected from SCS Design Report (1979). A limited number of compounds in trace quantities were identified in the samples collected (see Table 6-12).

Trace concentrations of dichloroethane, along with 11 unidentified large peaks for various organics totaling 47 ppm, were present in well 3. A slight change in total organic vapor concentration of 25 ppm was observed when the blower was off. Similar observations were recorded for well 7. Samples collected from wells 9 and 31 showed only trace concentrations of organic volatile compounds. Insignificant quantities of the same compounds were reported in the ambient sample collected near the pumphouse.

6.4.3 RI Monitoring (1984)

Because of the potential problems associated with gases suspected onsite an explosimeter, HNU, and other organic vapor analyzers were continually used during various phases of the RI reconnaissance, the drilling of boreholes, and the collection of samples. No explosive or toxic organic vapors were detected in the air. However, explosive gas levels (non-specific) were detected in the head-space of well MW-03, in the Northern Tract, during well development. The gas was purged prior to continuation of the development and no other incidents were reported.

6.4.4 FW Enviresponse, Inc. Investigation (1985)

FW Enviresponse, Inc., accompanied by IT Corporation and EPA, Cincinnati, conducted air sampling at five homes in Riverside Gardens on August 14, 1985.

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TABLE 6-12
EXOTIC GAS ANALYSIS (NOVEMBER, 1984)
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

	Blower On(1)				Blower Off(1)			
Parameter (ppm)	Well No. 3	Well No. 7	Well No. 9	Well No. 31	Well No. 3	Well No. 7	Well No. 9	Well No. 31
Benzene	-	0.75	0.038	0.019	-	0.18	0.044	0.053
Dichloroethane(2)	.016	0.62	0.014	-	0.015	0.054	-	-
Ethylbenzene	-	-	-	0.44	-	-	-	-
Heptane	-	1.3	-	-	-	-	-	-
Toluene	-	-	-	-	-	-	-	-
Xylenes	-	-	-	-	-	-	-	-
Unknown Peaks	11	3	0	-	11	1	-	-
Concentration(3)	47	7.2	1.0	1.0	25	2.1	1.0	1.0

"-" indicates none deteced. Detection Limits: All compounds 0.001 ppm
Xylenes 0.01 ppm.

(1) Samples were collected in the well headspace after the caps were removed.

(2) 1,1 and 1,2 dichloroethanes were computed together.

(3) Indicates number of unidentified peaks with concentrations reported as benzene equivalent.

Source: IT Corporation, 1984a.

TABLE 6-12
EXOTIC GAS ANALYSIS (NOVEMBER, 1984)
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY
PAGE TWO

Parameters (ppm)	Blower House Samples: Blower On	Blower House Samples: Blower Off
Benzene	-	0.006
Dichloroethane(2)	-	-
Ethylbenzene	-	-
Heptane	-	-
Toluene	0.058	0.003
Xylenes	-	-
Unknown Peaks	1.0	1.0

- Indicates none detected.

(1) 1,1 and 1,2 dichloroethanes were computed together.

Detection Limits: all compounds 0.001 ppm
Xylenes 0.01 ppm.

Source: IT Corporation, 1984b.

This study was performed after the field work and draft RI Report were completed. The results of the sample analyses were not received before this report was submitted; therefore, the data from this investigation are not evaluated here. This data will be evaluated in a later report and issued as an addendum to the RI/FS report.

6.4.5 SCS Engineers Investigation and County Repair of Gas Collection System (1985 - 1986)

On November 3, 1985, SCS Engineers conducted a preliminary investigation of the existing gas collection system at the request of the Jefferson County Department of Public Works. The results of this investigation were similar to the previous 1984 findings of the IT Corporation evaluation of the system. Repairs of the confirmed problem areas were begun on December 9, 1985 by Jefferson County under the supervision of SCS Engineers.

6.4.6 EPA Air Investigation (1985 - 1986)

EPA is currently conducting an air sampling program which will aid in determining whether the Riverside Gardens' residents are being adversely affected via air by the landfill. In order to address this issue, representative air data will be collected over a reasonable time period during varied climatic conditions (i.e. dry and wet periods).

In September 1985, air samples were taken inside and outside homes in Riverside Gardens. In January 1986, 70 air samples were taken on and in the vicinity of the Lees Lane Landfill Site. The organic concentration levels detected in both sampling rounds were low, in the part per billion (ppb) range. At these concentrations, clinically observable health effects from chronic, low concentration exposures to these organic compounds may be difficult to measure. A definite conclusion cannot be drawn until all data gaps have been filled. After all data have been reviewed, a report will be prepared by EPA and the Agency for Toxic Substances and Disease Register (ATSDR) which will address the investigation and findings of the air sampling program. This report will be attached as an addendum to the RI/FS report and the results of the investigation may affect the frequency of future air monitoring at the site.

6.5 Gas Migration Summary

Methane is a natural by-product of organic decomposition in landfills. The Lees Lane Landfill is not atypical of such landfills and, therefore, the generation of methane and other organic gases should be expected. Rising groundwater levels, rainfall, and freezing temperatures act to promote the lateral migration of gases produced at the site.

Lateral movement of landfill gas from the Lees Lane Landfill Site was established based on the monitoring performed in 1975 and 1978. Monitoring performed on Phase I wells indicated that methane was present along the entire perimeter of the landfill. Positive methane readings were recorded at probes from 25 to 475 feet outside the landfill, and at depths from 6 to 42 feet methane was detected at each of the 42 probes. Monitoring performed on Phase III wells found that methane was present in soils below Riverside Gardens as well. Positive methane readings were recorded at probes from 360 to 900 feet outside the landfill, and at depths from 9 to 46 feet. With the exception of probes at Well III-5 methane was detected at all Phase III probes.

The 1979 SCS Report indicated a probable negative concentration gradient between the landfill and Riverside Gardens. This suggest that the landfill was the source of the gases detected by SCS in subsurface samples collected under Riverside Gardens. The report provides substantial data on the type and approximate concentration of gases associated with the landfill before 1980. The studies, however, were limited to the detection and quantification of subsurface vapors and not of ambient air contaminants above the landfill or in the residential area.

The ambient air data collected by NEIC prior to 1980 indicated that there was no evidence of explosive levels of methane in the homes sampled. Because of the nature of the situation and type of gases involved continued assurances of safety, however, could not be given.

Prior to the installation of the gas collection system by SCS in 1980, measurements taken in the headspace of Phase I and III wells showed methane levels between 0 and 84% volume in air. After 1980, the data collected by Jefferson County from some of the same wells indicated that methane was not present in the well headspace. The detection of methane in well I-12 in 1984 during a period when the system gas collection pump was inoperable indicates that the system, when operating, is serving to mitigate the migration of landfill gases.

Samples collected by IT in 1984 suggest that the landfill is still generating toxic and explosive gases. Lateral migration of these gases into Riverside Gardens can be expected if the gas collection system becomes inoperable. The system is currently operating at less than 50% capacity. However, Jefferson County has initiated repairs on the system under the direction of SCS Engineers.

Based on available ambient air data collected around the site by NEIC and IT, there is no evidence to indicate that the landfill gases are present in sufficient concentrations to be a health hazard. Since most gases migrate in a relatively similar manner, the subsurface migration of gases from the landfill to the neighborhood is currently under control. The installation of the gas collection system, as previously stated, is acting to mitigate any potential problems associated with the landfill gases within the area.

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7.0 BIOTA INVESTIGATION

The purpose of the biota investigation was to identify the biota likely to frequent or inhabit the Lees Lane Landfill Site. This information is necessary to evaluate potential environmental impacts resulting from site contaminants, especially with reference to endangered or threatened species. Although no ecological surveys were undertaken at the site during the remedial investigation, adequate information on biological communities was available for the Mill Creek Cutoff area adjacent to the site (Army Corps of Engineers, 1982).

7.1 Flora

Most of the natural plant communities at the Lees Lane Landfill Site have been disturbed due to previous landfilling activities. The site has been closed for ten years, and a good secondary growth of grasses and shrubs has developed over much of the Central and Northern Tracts of the site. This brushland covers approximately 81 acres. A marsh area and open water areas exist in the Southern Tract of the site. The approximate surface areas of the marsh and open water are six acres each. The dominant wetland vegetation in the marsh is the common cattail (Typha latifolea). Both the marsh and open water areas are remnants of earlier quarrying and landfilling operations. The western edge of each tract along the Ohio River contains the only relatively undisturbed vegetation. This area occupies about 32 acres and has a dense growth of vegetation characteristic of riparian woods. According to the Army Corps of Engineers (1982), trees common to this type of community include silver maple (Acer saccharinum), red mulberry (Morus rubra), slippery elm (Ulmus rubra), and American elm (Ulmus americana). The dominant ground cover are generally jewel weed (Impatiens sp.) and burning nettle (Laportea canadensis). The riparian woods are subject to periodic inundation by the Ohio River.

Most of the natural vegetation north and south of the site has been removed to accommodate industry. The only exception is a strip of land in the Mill Creek Cutoff area immediately south of the landfill site.

7.2 Fauna

Although no ecological surveys were conducted on the Lees Lane Landfill Site, the diversity of habitats suggests the site could contain an abundant faunal population. Additionally, ecological surveys conducted immediately south of the site for the Mill Creek and Riverport Environmental Impact Statements (EIS) indicate an abundant mammal and bird population. The most diverse vertebrate populations were observed in the woodland/old field ecotone, while brushland habitats supported large populations of small mammals (Army Corps of Engineers, 1982). Since the Lees Lane Landfill Site has extensive brushland areas and woodland/brushland ecotones, populations similar to those observed immediately south of the site can be expected to occur at the site. Small mammals such as the prairie vole (Microtus ochrogaster), the house mouse (Mus musculus), the white-footed mouse (Peromyscus leucopus), and the woodland vole (Microtus pinetorium) can be expected to heavily utilize the brushland habitat.

The eastern cottontail (Silvilagus floridanus) is also probably common in the brushland and woodland edge areas, while the white-tail deer (Odocoileus virginianus) may occasionally occur at the site.

A list of mammals common to Jefferson County is provided in Appendix J.

In the Riverport EIS (Army Corps of Engineers, 1982), 79 species of birds were observed in the study area. The most common species were the common grackle (Quiscalus quiscla), American robin (Turdus migratorius), indigo bunting (Passerina cyanea), mourning dove (Zenaidura macroura), cardinal (Cardinalis cardinalis), gray catbird (Numetella carolinensis), and blue jay (Cyanocitta cristata). Additionally, large numbers of "blackbirds" were observed assembling into winter flocks.

Waterfowl were infrequently observed. Only two species, the blue-winged teal (Anas discors) and the wood duck (Aix sponsa) were noted in the study area. Teal were seen along the southern half of Lower Mill Creek, and wood ducks were noted in the woods along the northern half of Lower Mill Creek (Army Corps of Engineers, 1982).

The green heron (Butorides viresceus), the great blue heron (Arden herodius), and the black crowned right heron (Nycticorax hycticorax) were the only wading birds observed., They were noted in the Mill Creek area and in the larger wetland areas of the Riverport site about two miles to the south of Lees Lane Landfill (Army Corps of Engineers, 1982).

A list of bird species known to occur near the site is provided in Appendix K.

No aquatic surveys have been conducted in the wetland or open water areas on the Lees Lane Landfill Site, however the aquatic communities of the Ohio River and some of its tributaries have been studied extensively (Dames & Moore, 1975; 1977; Ohio River Valley Water Sanitation Commission (ORSANCO), 1962; 1976; and Army Corps of Engineers, 1982). ORSANCO (1976) identified approximatley 130 fish species that inhabit the river. The study indicates that changes in the fish communities have occurred as a result of activities such as dam construction, dredging and channelization, and increased pollution levels in the river.

In general, the most commonly identified fish species were coarse fish and are considered tolerant of lower water quality conditions found in the Ohio River. A list of fish species considered to be representative of species likely to occur in the Ohio River near the Lees Lane Landfill Site is provided in Table 7-1.

The invertebrate community of the Ohio River has also been subject to investigation. The Ohio River was sampled in 1968 from River Mile (RM) 538 through RM 648 for mussel identification. The results of this study (Army Corps of Engineers, 1982) showed that 23 mussel species inhabit this section of the Ohio River. One mussel bed was located between RM 614.1 and RM 617.5, the segment of the river adjacent to the site. However, this population of shellfish was positioned on the Indiana side of the river. Seven important species of shellfish, listed in Table 7-2, have been reported to exist between RM 538 and RM 648 of the Ohio River.

The benthic community of the Ohio River is limited in part by the lack of suitable substrate (Army Corps of Engineers, 1982). In some areas near the shoreline

TABLE 7-1
FISH SPECIES LIKELY OCCURRING
NEAR LEES LANE LANDFILL
JEFFERSON COUNTY, KENTUCKY

Scientific Name	Common Name
Polyodon spathula	Paddlefish
Alosa chrysochloris	Skipjack Herring
Dorosoma cepedianum	Gizzard Shad
Cyprinus carpio	Carp
Hybopsis storeriana	Silver Chub
Notropis atherinoides	Emerald Shiner
Notropis blennium	River Shiner
Notropis cornutus	Common Shiner
Notropis volucellus	Mimic Shiner
Carpiodes carpio	River Carpsucker
Carpiodes cyprinus	Quillback
Catostomus commersoni	White Sucker
Moxostoma carinatum	River Redhorse
Moxostoms crythrurium	Golden Redhorse
Ictalurus furcatus	Blue Catfish
Ictablurus melas	Black Bullhead
Ictalurus natalis	Yellow Bullhead
Ictalurus nebulosus	Brown Bullhead
Ictalurus punctatus	Channel Catfish
Pylodictus olivaris	Flathead Catfish
Morone chrysops	White Bass
Morone mississippiensis	Yellow Bass
Lepomis cyanellus	Green Sunfish
Lepomis gulosus	Warmouth
Lepomis macrochirus	Bluegill
Lepomis microlophus	Redear Sunfish
Micropterus salmoides	Largemouth Bass
Pomoxis annularis	White Crappie
Pomoxis nigromaculatus	Black Crappie
Stizostedion canadense	Sauger
Aplosinorua grunniens	Freshwater Drum

Source: Army Corps of Engineers, 1982.

TABLE 7-2
IMPORTANT SHELLFISH SPECIES
COLLECTED BETWEEN
RIVER MILE 538 AND RIVER MILE 648
OF THE OHIO RIVER

Scientific Name	Common Name
Quadrula quadrula	Maple leaf
Quadrula metanevra	Monkey face
Pleurobema cordatum	Pigtoe
Pleurobema pyramidatum	Pigtoe
Fusconaia ebenus	Niggerhead
Amblema costata	Three Ridge
Megalonaias gigantea	Washboard

Source: Army Corps of Engineers, 1982.

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there is a muddy substrate which serves as a habitat for oligochaetes (segmented worms). Farther away from the river bank, the substrate is typically sandy and the river currents are swifter so that conditions are too unstable to support a significant benthic community. Based on this general characterization, the benthic organisms near Lees Lane Landfill would be expected to be primarily comprised by oligochaetes. The segment of the Ohio River adjacent to the landfill is in the middle of a gradual curve such that the outside of the bend is on the Indiana side. The faster currents would then be expected to occur on the Indiana side of the river and the scouring action would lend itself to maintaining a sandy substrate on the Indiana side of the river. The identification of a mussel bed in this portion of the river on the Indiana side supports this assumption because shellfish require fast-moving waters. The Kentucky side of the river, being on the inside of the river curve, would be expected to have slower moving currents. The slower flow would allow for the settling of a muddy substrate in the area adjacent to the landfill. In summary, the characteristics of the invertebrate community as a whole in the river near the landfill is reported to be dominated by pollution-tolerant organisms (Army Corps of Engineers, 1982).

7.3 Endangered Species

A number of federally-listed endangered animal species known to inhabit the general area near the Lees Lane Landfill site are provided in Table 7-3. No plant species on the Federally endangered plant list exist in Kentucky.

7.4 Biota Summary

Although most of the natural plant communities at the site have been disturbed, a good secondary growth of grasses and shrubs have developed over the Northern and Central Tracts, while a low-lying area in the Southern Tract has developed into a wetland and open water area. Additionally, a dense growth of vegetation characteristic of riparian woods exists along the Ohio River.

The diversity of habitats at the site suggest the area could contain an abundant faunal population. Small mammals are expected to dominate the woodland and

TABLE 7-3
FEDERALLY LISTED ENDANGERED SPECIES OF GENERAL AREA NEAR LEES LANE LANDFILL JEFFERSON COUNTY, KENTUCKY

Scientific Name	Common Name
Mammals	
Myotis grisescens	Gray Bat
Myotis sodalis	Indiana Bat
Felis concolor cougar	Eastern Cougar
Birds	
Haliaeetus leucocephalus	Bald Eagle
Falco peregrinus anatum	American Peregrine Falcon
Falco peregrinus tundrius	Arctic Peregrine Falcon
Vermivora bachmanii	Bachman's Warbler
Campephilus principalis	Ivory-billed Woodpecker
Mollusks	
Epioblasma torulosa torulosa	Tuberculed-Blossom Pearly Mussel

Source: U.S. Fish and Wildlife Service, 1979.

brushland areas. These areas would also be conducive to birdlife. At this time, the wetland area does not appear to support a large waterfowl population.

Aquatic life in the Ohio River near the site are dominated by pollution-tolerant species. Fish species common to the area include gizzard shad, carp, and bullhead catfish.

Nine animal species common to the general area around the site are on the Federal endangered animal list.

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8.0 PUBLIC HEALTH AND ENVIRONMENTAL CONCERNS

The evaluation of public health and environmental concerns at the Lees Lane Landfill Site included a contamination assessment and a public health and environmental assessment. The contamination assessment defined the source of contaminants, transport mechanisms, and migration routes from the site. The public health and environmental assessment evaluated the exposure pathways, distribution of contaminants, and receptors at the site. Critical contaminants were selected for further evaluation of the potential public health and environmental effects of site contaminants. The conclusions of the public health and environmental assessment were the basis for establishing the objectives of remedial action at the site.

8.1 Contamination Assessment

The contamination assessment was based on the results of the investigations and contaminant characterizations conducted for each environmental medium. Within the assessment, the source of contaminants was evaluated to determine the potential for continued release of leachate and landfill gases produced as a result of waste decomposition. The mechanisms for contaminant transport were further evaluated to determine any mitigating circumstances likely to affect contaminant levels.

8.1.1 Source of Contaminants

The Lees Lane Landfill Site is located in the glacial outwash and alluvium of the Ohio River. Sand and gravel were quarried at the site as early as the 1940s and the excavated areas were probably landfilled concurrently with the quarrying operations.

The site is underlain by an alluvial aquifer extending to the shale bedrock approximately 110 feet below the land surface. The saturated thickness of the alluvial aquifer is approximately 60 feet, allowing a 50-foot buffer between the normal groundwater levels and the land surface. The depth of excavation at the site is unknown but most of the sand and gravel pits are not expected to have exceeded 25 feet.

The landfill was closed in 1975 and the fill appears to have been covered with local soil materials. The site was not graded to promote drainage and currently the landfill surface is irregular with a large depression located in the Southern Tract, where capacity remained when the landfill was closed. The cover material appears to be relatively permeable based on the lack of standing water observed during the conduct of the Remedial Investigation (RI).

The permeable cover material cannot be expected to inhibit infiltration of rainwater and subsequent leachate production. There is no evidence of the use of landfill liners or leachate collection systems to prohibit the migration of leachate to groundwater. It does not appear that the landfill has stabilized based on the observation of undulations in the access road probably caused by the compaction of wastes within the fill.

The volume of fill at the site has been estimated at 2.4×10^6 cubic yards, but little information is available as to the actual composition of the wastes. Municipal, industrial, and commercial wastes are known to have been disposed of in the landfill but no records exist as to the type or location of specific wastes. Based on a Congressional Survey conducted in 1979, both hazardous and nonhazardous wastes have been placed in the landfill and landfill practices at the time of operation suggest that these wastes were probably comingled within the various pits.

Access to the landfill is currently uncontrolled and recreational use is evident. Hunters and fishermen were observed regularly during the conduct of the RI. In addition, indiscriminant dumping on the landfill surface can be observed along the access road at various locations throughout the site.

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8.1.2 Transport Mechanisms

The transport of site contaminants is dictated by the release mechanism for the contaminant, the migration route, and the the applicable mitigating factors associated with each environmental media. These transport mechanisms are summarized in Table 8-1 and described in detail by environmental media.

8.1.2.1 Groundwater

The source of contaminants to groundwater is the result of leachate migration from the landfill. Continued leachate production is expected due to the permeable landfill cover. Containment of leachate is not expected since there are no known landfill liners or leachate collection systems in use at the site. Downward percolation of leachate through the natural alluvial and glacial outwash materials surrounding the fill is not expected to provide any measurable attenuation of contaminants.

The groundwater flow direction at the site is predominantly toward the Ohio River with discharge into the river. However, based on 60 feet of saturated thickness of the aquifer and up to 30 feet from the bed of the Ohio River to the shale bedrock below, there is a potential for contaminants to travel under the Ohio River and into Indiana. During periods of high flow in the Ohio River, contaminant migration may reverse. If this occurs, there is a potential for transport of landfill contaminants into Riverside Gardens. In addition, past operation of a pumping center to the northeast of the site may have diverted groundwater flow.

A careful evaluation of each of these migration routes was made as part of the RI. Continuous water level recorders were placed on two monitor wells and groundwater quality samples were collected throughout the site.

Under normal flow conditions in the Ohio River, most of the potentially contaminated groundwater can be expected to discharge to the river. Based on conservative estimates, the discharge to the Ohio River cannot be expected to

TABLE 3-1
CONTAMINANT TRANSPORT MECHANISMS
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Affected Area	Affected Media	Release Mechanism	Migration Route	Mitigating Factors
Offsite	Groundwater	Leachate	Into Ohio River Under Ohio River Into Riverside Gardens	Dilution Dilution Infrequent
	Surface Water Sediments Surface Soil	Runoff	Into Ohio River	Infrequent/Dilution
	Gas Migration	Excavation	Into Riverside Gardens	Collection System
	Air	Gas Production	Into Riverside Gardens	Dilution
Onsite	Surface Water Sediments Surface Soil Air	Unrestricted Access	To Pond in S. Tract To Pond in S. Tract To Pond in S. Tract Thru Cover Material	Infrequent Use

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exceed 1.69 cubic feet per second (cfs). The average flow of the Ohio River at Louisville is 114,000 cfs; and therefore, the groundwater contribution is 1.5×10^{-3} percent of the total flow.

Flow under the Ohio River is not expected to occur to any large extent based on the relatively flat bedrock in the area (dipping 8.3 feet per mile). Areas of high relief located less than a mile from the Indiana bank of the Ohio River may contribute to a steeper groundwater gradient in Indiana than groundwater at the site (the maximum observed gradient during the RI was 0.007). If flow under the Ohio River were to occur, some dilution from the river would be expected as the waters comingled beneath the river.

Continuous water level recorders placed on the monitor wells during the RI indicated a rapid groundwater response near the river in the Central Tract to rises in Ohio River stage. Little response to the pumping center to the northeast of the site was observed.

Flow reversal of shallow groundwater within the landfill boundaries was observed during the RI. During periods when the Ohio River water levels were high (greater than 400 feet above mean sea level (amsl)), the monitor well near the river in the Central Tract exhibited a water level at a higher elevation than the monitor well east of the Northern Tract.

The potential exists for the migration of landfill contaminants into Riverside Gardens. Samples from residential wells were collected in 1978 and again as part of the Remedial Investigation. The distribution of contaminants within the groundwater samples is sporadic and does not suggest migration from the landfill boundary.

The flow rate of groundwater was calculated to be 420 feet per year using nonconservative parameters. Based on an approximate width of the landfill of

1,500 feet, it can be expected that groundwater entering the site at the upgradient boundary would travel approximately 3.6 years beneath the landfill before discharge to the Ohio River. Accounting for variations in gradient due to higher water levels in the Ohio River, this flow rate should not be expected to be more than double. In addition, periods of flow reversal or higher water levels resulting from infiltration of Ohio River water should be expected to carry leachate produced by the landfill directly to the Ohio River thus reducing the time available for contaminant dispersal throughout the aquifer.

8.1.2.2 Surface Water

The potential sources of contamination for surface water at the site include runoff over contaminated surface soils, leachate seeps and groundwater discharge. Based on the permeability of the cover material, most runoff is expected to infiltrate the fill in the Northern and Central Tracts rather than to stand on the landfill surface. The topography of the Southern Tract suggests that some runoff is likely to accumulate in the pond formed by a depression resulting from incomplete filling.

The floodwall/levee at the site extends along two sides of the landfill boundary, prohibiting runon of surface waters. In addition, a topographic high on the third side of the landfill tends to inhibit runon in this area. Therefore, little runon occurs at the site and most of the runoff leaving the site is discharged directly to the Ohio River (the fourth side of the landfill). A small amount of runoff enters Mill Creek Cutoff near the Ohio River, but it is expected to be transported immediately to the Ohio River.

The evaluation of the effects of flooding at the landfill suggests that very little inundation of actual waste-filled areas occurs at less than the 50-year flood level (designated at 444 feet amsl). The 100-year flood level (designated at 447 feet amsl) would cover approximately 25 to 50 percent of the landfill and the 500-year flood level (designated at 452 feet amsl) would essentially cover the entire site.

Under the 100-year flood conditions, the Northern Tract, small portions of the Central Tract and approximately one-half of the Southern Tract where the large depression currently exists would be affected. Some scouring of the landfill cover would be expected, as well as increased infiltration resulting in increased leachate production within the landfill. Groundwater reversal could carry landfill contaminants into Riverside Gardens if the period of flooding were sufficiently long.

Water quality analyses were performed on surface water samples collected from a marsh and the pond in the Southern Tract and small areas of standing water in the Northern and Central Tracts. The evaluation of the results suggested that very low levels of contamination were present. A comparison of water levels in the pond and in the Southern Tract with nearby groundwater levels did not suggest the potential for groundwater discharge to the pond. Comparison of nearby groundwater quality to surface water quality in the pond confirmed the above evaluation based on water levels. In addition, the levels of contaminants in the pond did not suggest that leachate was being discharged to the pond in significant quantities.

8.1.2.3 Sediments and Surface Soils

The sources of contamination of surface soils include past activities such as dumping or staging of drums during removal operations and discharge of leachate seeps. The surface soils are considered to be the source of contamination to sediments based on the lack of site drainage patterns previously discussed.

The migration routes are expected to be the same as those for surface water. Runoff containing eroded surface soils will be discharged to the Ohio River or the pond in the Southern Tract. Since the level of contamination of the cover materials is expected to be uniform throughout the site, except as a result of specific past activities, the sediments in the pond in the Southern Tract are expected to be characteristic of transported surface soils.

The potential "hot spot" surface soils associated with indiscriminate dumping were evaluated through the collection of soil samples in areas exhibiting visual evidence of vegetative stress. It is assumed that the majority of the landfill cover is less contaminated than these "hot spot" soils. Potential public contact with these soils is not expected since the areas were identified based on visual evidence and such soils would probably be avoided at the site.

Soil and sediment analyses were performed as part of the RI. The evaluation of the results of these analyses suggested little variation in the concentration of contaminants in the surface soils and sediment from those found in offsite soils in Riverside Gardens. This similarity confirms that the landfill was probably covered with local soils.

8.1.2.4 Air

The potential source of contaminants to ambient air is the release of toxic organic compounds produced by the decomposition of landfill wastes. The subsurface migration of landfill gases into Riverside Gardens was documented from 1975 to 1979. The production of these gases can be expected to decrease with time as the landfill stabilizes, but studies conducted in 1984 confirm that the gases are still being produced.

These gases will migrate radially from the landfill, including both lateral and vertical migration. Release of the gases at the landfill surface is expected based on the permeability of the landfill cover material. However, migration of the gases into Riverside Gardens is currently prohibited by the operation of a gas collection system installed at the site in 1980. Prior to the installation of the system, the migration of methane was measured in observation wells located up to 900 feet from the landfill boundary. If methane is allowed to migrate from the site, in the subsurface soils, it should be expected that toxic organic compounds produced by the landfill would also migrate with the methane gas.

There is only minimum data available on ambient air concentrations of toxic organic compounds at the site. However, there was no evidence of ambient air contamination problems in the two studies conducted in 1975 and 1978. Presumably, this is the result of high dilution once the gases are released to the air.

8.2 Public Health and Environmental Assessment

The purpose of the assessment is to evaluate the potential health risks associated with the presence of hazardous substances at the Lees Lane Landfill Site. During this assessment, the source of contamination, routes of transport, and potential receptors at the site were evaluated. Selection of critical contaminants was based on physical and toxicological information, environmental criteria, and compound-specific transport, potential exposure pathways, and toxicity. Impacts on human and environmental receptors resulting from contaminants at the site were also evaluated based on hydrogeological and chemical analytical data obtained during the RI. The basis for this assessment is presented in Table 8-2.

In general, the public health assessment describes the hazardous compounds of greatest concern, assesses the significant contaminant migration routes and exposure pathways that have been identified, and evaluates potential adverse effects to the susceptible receptors. Several factors were considered during the implementation of this evaluation. They include:

- Present site conditions pertinent to the public health assessment, as defined by the RI
- Physical, chemical, and biological characteristics affecting the environmental fate and mobility of the contaminants
- Health effects and the environmental impacts associated with exposure to the contaminants, including additive, synergistic, or antagonistic effects.

Some limitations affected the extent these factors could be evaluated and therefore constrained the scope of the assessment and the conclusions that could be inferred. The limitations included the quality of the laboratory analytical data, availability of toxicological data on the contaminants present, relevance of toxicological data to site-specific exposure scenarios, and the degree to which probabilities of exposure could be estimated or predicted. Although some limitations did exist, they were not severe and did not prevent the development of a public health assessment.

TABLE 8-2
BASIS OF PUBLIC HEALTH AND ENVIRONMENTAL ASSESSMENT
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Affected Area	Release Mechanism	Affected Media	Migration Route	Exposure Pathway	Receptors
Offsite	Leachate	Groundwater	Into Ohio River	Biological Uptake	Downstream Users
			Under Ohio River	Ingestion	Ind. PWS Users
			Into Riverside Gardens	Ingestion	Residental Well Users
	Runoff	Surface Water	Into Ohio River	Biological Uptake	Flora and Fauna
		Sediments	Into Ohio River	Biological Uptake	Flora and Fauna
		Surface Soil	Into Ohio River	Biological Uptake	Flora and Fauna
	Gas Production	Gas Migration	Into Riverside Gardens	Combustion	Homes in Riverside Gardens
		Air	Into Riverside Gardens	Inhalation	Residents in Riverside Gardens
Onsite	Unrestricted Access	Surface Water	To Pond in S. Tract	Direct Contact	Recreational Users
		Sediments/Soils	To Pond in S. Tract	Direct Contact	Recreational Users
		Air	Thru Cover Material	Inhalation	Recreational Users

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8.2.1 Exposure Pathways

Exposure pathways are the routes by which suseptible receptors may be exposed to a contaminant. Primary exposure pathways include ingestion, inhalation, and dermal contact. Ingestion may take the form of direct exposure through drinking or eating materials which are contaminated or may involve indirect routes such as use of contaminated water for food preparation. Direct inhalation exposure results from breathing air which has become contaminated through volatilization, release of gas-phased contaminants, or entrainment of airborne particulates. In the case of particulate inhalation, the physical size of the particulate as well as chemical characteristics play a major role in determining the severity of the exposure since the size range for "respirable" particulates is very restricted. Dermal exposure may result from direct contact with contaminated water, soil or other material, or may involve indirect contact such as transfer of contaminants from original sources to clothing and furniture and subsequent skin contact. Any of these exposure pathways may result in an acute exposure, which involves short time duration and frequency of exposure or chronic exposure, which is of longer duration and is continuous or frequent. The major exposure pathways of concern to receptors at the Lees Lane Landfill Site are shown for each media in Table 8-2.

8.2.2 Current Contaminant Levels

A wide array of contaminants were found at low levels in the various media at the Lees Lane Landfill Site. Most were found only sporadically and were not considered representative of the typical site conditions. Some of these contaminants included plasticizers (phthalates), heavy metals, pesticides, and solvents. The site contaminants could potentially reach receptors through inhalation, ingestion or contact with contaminated media. The various transport routes which could potentially deliver the contaminants to the receptors include subsurface gas migration, particulate or gas migration in open air, surface water runoff, and groundwater discharge. Receptors could also be affected by direct dermal contact with locally contaminated surface soils.

8.2.2.1 Groundwater

Pollutant movement in the groundwater system is the major transport route to potential offsite receptors and will be examined more closely in this assessment. A small number of shallow, private drinking water wells are located in the Riverside Garden subdivision, east of the site. No elevated contaminant levels were found in these wells (see Tables 4-12 through 4-15). Two deep industrial process wells are also located north and south of the site and are operated by Borden and Louisville Gas and Electric. Analyses conducted during the remedial investigation did not reveal any elevated levels of hazardous contaminants in the wells (see Tables 4-10 and 4-11). Two public water supply wells withdrawing from the deeper portions of the aquifer are located on the Indiana side of the Ohio River. No contaminants typical of the site were found at elevated levels in these wells, although manganese was observed in excess of the secondary drinking water standard. As seen in Table 4-8, manganese, iron and chromium appear to be widespread in the deep portions of the aquifer. These substances were observed in upgradient monitor wells, onsite monitoring wells, and the Indiana public water supply wells. Although the site may contribute to the elevated levels, it does not appear to be the sole source.

8.2.2.2 Surface Water

The contaminants in the onsite surface soils could potentially reach offsite receptors by migrating with surface water runoff. In the Northern and Central Tracts, surface water is primarily discharged to the groundwater due to topography and permeable cover soils. Surface water runoff in the Southern Tract, however, flows into the low-lying pond water area. Based on topographic features, the pond area appears to be a sink for some of the pollutants in the surface water runoff. Even so, pollutant levels in standing water and in sediments in these areas are relatively low or nonexistent. The contaminants found in surface water and bottom sediments are shown in Tables 5-7 through 5-12. Surface water runoff from the site is to the Ohio River.

8.2.2.3 Sediments and Surface Soils

In general, the sediments and surface soils at the site are not contaminated. Low levels of two contaminants chromium, and lead were observed in two localized areas (see Tables 5-3 through 5-6). These areas were along the access road in the Central Tract, possibly indicating sporadic dumping. Receptor contact with these areas could potentially lead to exposure, however, the "hot spots" do not represent a serious problem since they are not typical of general site conditions . They can be easily covered to minimize receptor exposure.

8.2.2.4 Subsurface Gas Migration

In early 1975, a gas was detected in homes and septic tank vents in the Riverside Gardens residential subdivision. Analyses conducted by the EPA and SCS Engineers between 1975 and 1978 revealed the gas was composed primarily of carbon dioxide and methane. In areas close to the Lees Lane Landfill Site, methane concentrations were commonly above 20% volume in air, which is sufficient to cause an explosion hazard. Analyses for gases other than methane were also conducted and revealed the presence of a number of toxic gases in test well headspaces throughout the residential area. Some of the toxic gases observed included vinyl chloride, benzene, dichloroethane, ethylbenzene, and toluene. In 1980, a gas collection system was installed at the site boundary adjacent to the residential area to intercept gases migrating in the subsurface. Testing in 1984 by IT Corporation indicates that the gas collection system appears to have temporarily eliminated the gas problem to the nearby residences. Subsurface gas migration should not affect residences as long as the system is operating properly.

8.2.2.5 Ambient Air

No representative sampling of the air medium was undertaken during the RI. The critical contaminant levels observed in the various media do not appear to represent a serious threat by this transport route. Subsurface disturbances, however, could potentially release some hazardous gases to the air. The ambient air levels resulting from such disturbances are not known.

The EPA is currently conducting an air sampling program to determine if an ambient air problem exists at the site. A report will be prepared by EPA and the Agency for Toxic Substances and Disease Register after all the data is received from the air sampling program. This report will be attached as an addendum to the RI/FS report.

8.2.3 Receptors

The Lees Lane Landfill Site is located in a mixed landuse area. Industrial operations are located immediately north and south of the site, while a large residential area is located immediately to the east. An estimated 1,470 people live within a one-mile radius of the site (NUS, 1983). A large tract of undisturbed land in the Mill Creek Cutoff area and the diversity of habitats on the Lees Lane Landfill Site suggest that numerous environmental receptors could also be affected by contaminants at the site.

8.2.3.1 Groundwater

Most residents in the area use public water, however, approximately eleven homes still use domestic wells tapping the alluvial aquifer. Of these eleven wells, only eight are used for drinking water. Industrial wells north and south of the site and Indiana public water supply wells on the west side of the Ohio River withdraw water from the alluvial aquifer. The public water supply wells in Indiana supply the Edwardsville Water Company which serves approximately 1700 connections directly and supplies water to two other water companies.

Ingestion of contaminated groundwater is the primary exposure pathway to the human receptors near the landfill site.

8.2.3.2 Surface Water

Analytical data collected during the Remedial Investigation indicate the levels of contamination of onsite surface water and sediment are low. The open water area acts as a sink receiving surface water runoff from the Southern Tract, while in the

Northern and Central Tracts, infiltration of surface water into the alluvial aquifer is the dominant transport route. The Ohio River is the receiving waterbody for surface water runoff from the site.

The most likely receptors would include people using the site for recreation and biota living or feeding in the wetland/open water areas or in the nearshore area of the Ohio River. The dominant exposure pathways would be through dermal contact to humans and ingestion to biota.

8.2.3.3 Sediment and Surface Soils

Analytical data collected during the remedial investigation show that in selected areas of the site ("hot spots"), surface soils are contaminated with low levels of various inorganic and organic chemicals. The contaminants observed are chromium and lead. Receptors most likely to be exposed to these contaminants include trespassers, hunters children, remediation workers, and biota at the site. Short-term dermal contact with contaminated soils is the most probable exposure pathway.

8.2.3.4 Air

Prior to the installation of the gas collection system between the landfill and the Riverside Gardens area. subsurface migration of methane and toxic gases represented a potential threat to the nearby residents due to possible explosion or chronic exposure to hazardous gases. This problem has been temporarily alleviated by the gas collection system. Insufficient ambient air data are available to determine receptor impacts from this source. The levels of contaminants observed in the various media suggest the problem is not significant unless the subsurface is disturbed.

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8.2.3.5 Biota

Biota residing at or migrating through the site may become contaminated through all three exposure pathways. The woodland/brushland ecotones should contain an abundant rodent population, based on nearby ecological surveys (COE, 1982), which could also attract predators to the site. Although no large waterfowl or wading bird populations frequent the area, the marsh and open water areas could potentially attract wildlife. The primary human receptors that could be potentially affected by contaminated biota are hunters and fishermen who may visit the site.

8.2.4 Selection of Critical Contaminants

A number of inorganic and organic contaminants were detected in the various media at the Lees Lane Landfill Site. The majority of the contaminants observed have relatively low toxicities or were found infrequently and were not considered typical of the site conditions in general. A select few, however, were widespread at the site or had important chemical or biological toxicological properties, and were considered contaminants of concern.

Hazardous gases and methane have the potential for subsurface migration to the Riverside Gardens area; however, the operation of the existing gas collection system between the landfill and the residences has temporarily mitigated the problem. The public health assessment will therefore concentrate on the contaminants in the groundwater system, since it is these contaminants which could migrate from the site and affect offsite receptors. All of the contaminants detected in the groundwater at or near the site are shown in Table 8-3.

Receptors could be exposed to the low-level contamination in all media; however, offsite migration of the groundwater contaminants presents the most serious potential health problem to the neighboring human receptors since this problem has not been mitigated.

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TABLE 8-3
CONSTITUENTS FOUND IN GROUNDWATER
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Parameter	Range (ug/l)
Extractable Organics	
Di-N-Butyl Phthalate	0-8
Bis(2-Ethylhexyl)Phthalate	0-20J
Phenol	0-300J
4-Methyl Phenol	0-2J
Methylpentanoic Acid	0-6J
Pentanoic Acid	0-7JN
Butenoic Acid	0-10JN
Octanoic Acid	0-9JN
Hexanoic Acid	0-10JN
Dodecanoic Acid	0-20JN
Hexadecanoic Acid	0-10JN
Tetradecanoic Acid	0-5JN
Benzoic Acid	0-2J
Ethylhexanoic Acid	0-10JN
Benzeneacetic Acid	0-10JN
Hexahydroazepinone	0-50JN
Purgeable Organics	
Chloroform	0-5J
Benzene	0-450
Toluene	0-10J
Propanol	0-200JN
2-Propanol	0-9,000JN
Ethanol	0-30JN
Butanol	0-10JN
Butanoic Acid, Ethyl Ester	0-50JN
Butanoic Acid, Butyl Ester	0-20JN
Methyl Ethyl Ketone	0-30J
Dichlorofluoromethane	0-6JN
Methyldioxalane	0-5JN
Diethylether	0-40JN
Carbon Disulfide	0-49
Inorganics	
Silver	0-15
Arsenic	0-87
Barium	0-1,100
Cadmium	0-22
Cobalt	0-160
Chromium	0-640

TABLE 8-3
CONSTITUENTS FOUND IN GROUNDWATER
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY
PAGE 2

Parameter	Range (ug/l)
Inorganics (cont'd)	
Copper	0-220
Nickel	0-340
Lead	0-150
Vanadium	0-270
Zinc	0-3,200
Aluminum	0-85,000
Manganese	0-7,900
Calcium	0-350,000
Magnesium	0-150,000
Iron	0-190,000
Sodium	0-63,000
Cyanide	0-20J
Potassium	0-61,000
Chloride	0-63,000
Sulfate	0-630,000

Significant differences in concentrations, frequency of detection, and the physical, chemical, and biological characteristics of these contaminants were evident. An evaluation of all the characteristics for each contaminant is not necessary, however, for the completion of a public health assessment. A detailed examination of a set of major contaminants will provide adequate input for the Feasibility Study (FS), and will result in a representative analysis of existing site conditions.

The following criteria were used to select or exclude the critical contaminants from the public health assessment:

- Tentatively identified compounds were not considered. Contaminants omitted for this reason include: hexahydroazepinone, pentanoic acid, butanoic acid, octanoic acid, hexanoic acid, tetradecanoic acid, ethylhexanoic acid, benzene acetic acid, propanol, 2-propanol, ethanol, butanol, butanoic acid (ethyl ester), butanoic acid (butyl ester), dichlorofluoromethane, methyldioxalane, and diethylether.

- A contaminant was eliminated from consideration as a critical contaminant if it were found infrequently so that it was estimated to not be widely enough distributed to result in a potential health risk. Contaminants eliminated by this criterion are: phenol, 4-methyl phenol, toluene, carbon disulfide, silver, cadmium, cobalt, vanadium, and cyanide.

- If there were significant health consequences based on toxicological potential or level of exposure associated with an individual contaminant in site-specific circumstances, it was considered significant and included in the assessment. Conversely, if the opposite were true, the contaminant was not considered. Contaminants omitted for this reason include: di-n-butylphthalate, bis(2-ethylhexyl)phthalate, methylpentanoic acid, benzoic acid, methyl ethyl ketone, barium, copper, nickel, zinc, aluminum, manganese, calcium, magnesium, iron, sodium, potassium, chloride, and sulfate.

As a result of the application of these selection criteria, only four contaminants remained. These contaminants are considered critical contaminants and potential health effects related to exposure to them will be more thoroughly examined.

Table 8-4 provides a summary of the range of concentrations of the critical contaminants' found in the various media at the Lees Lane Landfill Site. Table 8-5 provides the concentrations of the critical contaminants in the shallow portion of the aquifer, while Table 8-6 provides the concentrations in the deeper portion of the aquifer.

Iron and manganese were frequently detected in elevated levels in groundwater in the vicinity of the site. Since these elevated levels were widespread and detected in background samples, the problem appears to be areawide and not specifically related to the site. Although iron and manganese exceeded the National Secondary Drinking Water Standards in a number of onsite monitoring wells and offsite public drinking water wells, it will not be addressed in detail since these two constituents have low mammalian toxicities. Toxic effects associated with iron and manganese generally only occur from occupational exposure to dusts and fumes. Adverse effects have not been reported from oral ingestion in man or animals. The main reason for limiting iron and manganese concentrations in drinking water is for aesthetic reasons and to prevent objectionable tastes.

8.2.5 Potential Health Effects

The evaluation of the potential health effects of the critical contaminants identified at the Lees Lane Landfill Site includes an examination of the environmental fate and the chemical and biological toxicological properties of each contaminant, a review of compound-specific environmental criteria and a summary of potential toxic effects to the general population near the site.

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TABLE 8-4
CRITICAL CONTAMINANT LEVELS IN VARIOUS MEDIA
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Critical Contaminant	Groundwater ug/l	Surface Water ug/l	Bottom Sediments mg/kg	Surface Soil mg/kg
Lead	0-150	0-10J	10J-100J	50J-2,000J
Arsenic	0-87	0	5.4-27	0-25
Benzene	0-450	0-5J	0-15J	0
Chromium	0-640	0-6.2	9.8-30J	10J-2,000J

J - Estimated value.

\- Not detected.

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TABLE 8-5
CRITICAL CONTAMINANTS IN GROUNDWATER
TOP OF AQUIFER
JEFFERSON COUNTY, KENTUCKY

Critical Contaminant in ug/l	Upgradient Shallow Well MW-1 12/84	Onsite Shallow Wells 12/84	Downgradient at Ohio River WP 1-6 11/84
Lead	7.2	0 - 150	17 - 83
Arsenic	-	0 - 87	0 - 60J
Benzene	-	0	0 - 450
Chromium	43	12 - 140	0 - 33

- Not detected.

J Estimated value.

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TABLE 8-6
CRITICAL CONTAMINANTS
BOTTOM OF AQUIFER
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Critical Contaminant in ug/l	Upgradient MW-2		Northern Tract East of Fill MW-3		Central Tract Onsite MW-4		Southern Tract Onsite MW-5		Downgradient Indiana Public Supply Wells		Industrial Wells
	12/84	1/85	12/84	1/85	12/84	1/85	12/84	1/85	12/84	1/85	12/84
Lead	28	23J	20	68J	15	17J	11	44J	10	2.8J	-
Arsenic	-	-	-	4.3	-	7.3	-	8.1	-	-	-
Benzene	-	20	-	-	-	-	-	-	-	-	-
Chromium	120	57J	640	210	230	30J	360	400	12	R	-

- Not detected.
J Estimated value.
R Quality Control indicates data are unuseable.

Chemical toxicity results from acute and chronic exposure to the contaminants. Acute exposure is a single short-duration exposure and chronic exposure involves repeated or continuous exposure to low levels of the contaminant. Established environmental health criteria for the critical contaminants are provided in Table 8-7. The biological toxicity effects examined for the critical contaminants include carcinogenicity, mutagenicity and teratogenicity. The carcinogenicity of a chemical is based on its potential to induce cellular changes resulting in cancer formation. Mutagenicity is the ability of chemicals to cause changes in genetic materials in ways that can be transmitted during cell division, while teratogenicity is based on a chemical's ability to cause birth defects. Table 8-8 provides the biological toxicity characterisitcs of the contaminants of concern. Additional information on the chemical and biological toxicity of the critical contaminants and the health effects of iron and manganese are provided in Appendix L.

These classifications are generally qualitative but represent the best information available at this time. Care has been taken in interpretation of results, extrapolation of animal toxicity test data to human application, and development of qualitative conclusions based on incomplete and inconclusive data.

The qualitative risk assessment of environmental and health impacts which follows combines currently available health effects data with an evaluation of a site-specific determination of exposure probability.

8.2.5.1 Lead

Lead is a soft, gray, heavy, ductile metal which is found in nature in the sulfide (galena), the sulfate (anglesite) and the carbonate (cerrusite) mineral deposits. Approximately one-half of the lead produced is used in storage batteries, one fifth in gasoline additives (decreasing, however), and the remainder in lead-containing alloys, solders, pigments and ceramics.

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TABLE 8-7
CRITICAL CONTAMINANTS
ENVIRONMENTAL CRITERIA
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Compound	Human Health Criteria (Ingestion)	Threshold Limit Values Time Weighted Average (TLV-TWA) (Inhalation) (a)	Aquatic Life Criteria
Lead	50.0 ug/l (b)(c)	0.15 mg/m^3	Depends on water hardness. 170 ug/l at hardness measured as 100 mg/l calcium carbonate.
Arsenic	50.0 ug/l (b)(c) 22,000 ug/l (d)	0.2 mg/m^3	440 ug/l
Benzene	6.6 ug/l (c)	30 mg/m^3; 10 ppm	-
Chromium	50.0 ug/l (b)(c)	0.05 mg/m^3	21 ug/l

(a) TLVs for Chemical Substances in the Work Environment Adopted by ACGIH 1984-1985.
(b) National Interim Primary Drinking Water Standard Maximum Contaminant Level
(c) Kentucky Water Quality Standard
(d) Criterion associated with a human lifetime cancer risk of 10^{-5}

\- Not established.

Source: See Appendix L.

LEE 001 0010065

TABLE 8-8
CRITICAL CONTAMINANTS
BIOLOGICAL TOXICITY PARAMETERS
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Contaminant	Maximum Observed Concentration* (ug/l)	Carcinogenicity	Mutagenicity	Reproductive/Teratogenic Effects
Lead CAS No. 7439-92-1	150	Certain lead compounds are carcinogenic in test animals. IARC considers the animal evidence of dubious significance to man.	No excess chromasome damage in cultured leukocytes obtained from cows accidentally poisoned with lead.	No evidence that lead has a teratogenic effect in man. Has been shown to have teratogenic effects in test animals.
Arsenic CAS No. 7440-38-2	87	Ingestion and inhalation exposures increase the risk of skin and lung cancer in humans.	Chromasomal aberrations noted in human cell cultures exposed to sodium arsenate.	Sodium arsenate induces developmental malformations in a variety of test animals.
Benzene CAS No. 71-43-2	450	Carcinogenic in mice and rats. Suspected of causing leukemia in humans.	Causes microlesions in Salmonella typhimurium, Drosophila melanogaster. Causes macrolesions in rats and man.	Causes cleft palate, micrognathia and agnathia in mice.
Chromium CAS No. 7440-47-3	640	Suspected of causing lung cancer in humans. Rats injected with calcium chromate developed tumors at the point of injection.	Causes microlesions in E. coli. Causes chromasomal aberrations in mouse fetal cells.	Insufficient data available to make an evaluation of teratogenicity.

* Concentrations shown are for groundwater.

Source: See Appendix L.

Environmental Fate

Lead is considered insoluble in water, but may be solubilized in some acids. The solubility of lead compounds in water increases as the pH and the concentration of dissolved salts decreases. Hem and Durum (1973) found the solubility of lead to range from 10,000,000 ug/l at pH 5.5 to 1 ug/l at pH 9.0. Lead does not move readily through normal groundwater or surface water because it forms insoluble carbonates and sulfates and binds to organic ligands of flora and fauna.

Food has traditionally been considered the major source for lead exposure in humans. Surface deposition of lead on plants and vegetables and uptake via roots are the prime pathways. There is little evidence for the biomagnification of lead in the food chain; thus, fish are not usually considered a significant source.

Health Significance

Lead is commonly found in nature, being a natural component of the earth's crust. Most natural groundwater has concentrations ranging from 1 to 10 ug/l. In a survey of 969 U.S. water systems, 1.4 percent were found to have concentrations of lead in excess of the 50 ug/l drinking water maximum contaminant level (McCabe, 1970). Potentially hazardous lead exposures to man via drinking water have usually been linked to lead-lined storage tanks or pipes.

During the RI, lead was a common constituent at the site. In a sample of waste material (SS-22) from the Central Tract, the lead concentration was 20J mg/kg. In background soils (SS-41), the lead concentration was 50J mg/kg. Lead levels in "hot spot" soil samples ranged from 50J to 2,000J mg/kg. The highest concentration was found at SS-23 in the Central Tract. No criteria have been establised for lead in soils, however the Department of Health and Human Services (DHHS, 1983) indicate that naturally occurring lead ranges from 2 to 200 mg/kg in soils nationwide.

Lead concentrations in surface water on the site ranged from 0 to 10J ug/l, while the concentrations ranged from 10 to 100J mg/kg in bottom sediments. No lead was detected in nearshore Ohio River surface water samples. The ambient water quality criterion to protect freshwater aquatic life is dependent on water hardness and ranges from 74 to 400 ug/l total recoverable lead. Lead concentrations are well with in this criterion and the 500 mg/kg alert level established by the USGS (1977) for river bottom materials.

The lead concentration in the shallow background well (MW-01) was 7.2 ug/l. The lead concentration in onsite shallow monitoring wells ranged from undetectable to 150 ug/l. The latter concentration was detected in LL-9, which also had elevated chromium and arsenic levels. The lead level in the deep upgradient monitoring well (MW-02) ranged from 28 to 23J ug/l between December 1984 and January 1985. The lead concentrations in the deep onsite monitoring wells ranged from 11 to 68J ug/l. The latter concentration was detected in MW-03. No lead was observed in the industrial wells adjacent to the site, however the concentrations in the Indiana public water supply wells ranged from undetectable to 10 ug/l. The lead concentrations in the private residential wells ranged from undetectable to 32 ug/l. In only two instances were the lead concentrations in excess of the National Interim Primary Drinking Water Regulation (NIPDWR) maximum contaminant level of 50 ug/l (EPA, 1977.). These levels were 150 ug/l in LL-9 and 68J ug/l in MW-03.

In general, lead was detected at low levels in the soil and water media at the Lees Lane Landfill Site. Based on the observed levels, it is unlikely that lead represents a significant public health threat.

8.2.5.2 Arsenic

Arsenic is a silver-gray, brittle, crystalline, metallic-looking substance. It exists in three allotropic forms, the yellow (alpha), black (beta), and the grey (gamma) modifications. It is insoluble in water but is soluble in nitric acid. Arsenic is used as an additive for metals, especially lead and copper (90 percent); in electronic devices (7 percent) and as a chemical intermediate for arsenicals used in veterinary medicines (3 percent).

Environmental Fate

Elemental arsenic is seldom encountered in natural waters and is considered of low toxicity because of its virtual insolubility in water or body fluids (EPA, 1976). Soluble inorganic arsenate (pentavalent) compounds predominate under normal conditions over the less stable arsenite (trivalent) compounds. Waters of low pH and low dissolved oxygen favor the formation of lower oxidation state compounds such as arsenite. More basic, less oxygenated waters favor the formation of pentavalent arsenates (Ferguson and Gavis, 1972).

Arsenic is present in nearly all foods, with fish and seafood containing the most and fruits the least. It is estimated that the intake rate for arsenic is 1 mg/yr from the consumption of terrestrial foods.

Health Significance

Arsenic is a naturally occurring element which has been detected in surface water, groundwater, and soils. In a survey of 1577 surface waters, 87 contained arsenic in concentrations ranging from 5 to 336 ug/l with a mean of 64 ug/l (Kopp, 1969). According to the National Academy of Science (1977), most of the high levels of arsenic in surface waters are attributable to industrial contamination, with smelters and power plants also important sources. Based on toxicological studies, EPA has established an ambient water quality criterion of 440 ug/l of total recoverable trivalent arsenic for the protection of aquatic life.

During the Remedial Investigation, arsenic was observed at low levels in the soil and water media. The arsenic concentration in a sample of waste material (SS-22) was 190 ug/l, while it was 24 mg/kg in background soils (SS-41). The arsenic concentration in surface soils ranged from 0 to 25 mg/kg. The DHHS (1983) indicates arsenic concentration in surface soils generally range from 0.1 to 40 mg/kg.

No arsenic was reported for onsite surface waters, however arsenic concentrations ranged from 5.4 to 27 mg/kg in bottom sediments. These concentrations are well below the 200 mg/kg alert levels established by the USGS (1977) for river bottom material.

Arsenic was not detected in the shallow upgradient monitoring well (MW-01). The arsenic concentration in onsite shallow monitoring wells ranged from undetectable to 87 ug/l. The latter concentration was detected in LL-9, which also had elevated chromium and lead levels. Arsenic was also not detected in the deep upgradient monitoring well (MW-02), and concentrations in the lower portion of the groundwater onsite ranged from undetectable to 8.1 ug/l. No arsenic was detected in private residential wells and arsenic was not reported for the industrial process wells or the Indiana public water supply wells. In only one instance was the arsenic concentration in groundwater in excess of the NIPDWR maximum contaminant limit of 50 ug/l (EPA, 1977). This was at monitoring well LL-9 which had an arsenic concentration of 87 ug/l.

In summary, arsenic was detected at low levels in the soil and water media at the Lees Lane Landfill Site. Based on the levels observed, it is unlikely that arsenic represents a significant public health threat.

8.2.5.3 Benzene

Benzene is a liquid hydrocarbon produced principally from distillation of petroleum by catalytic reforming of light naphthane from which it is isolated by distillation or solvent extraction. Benzene is used extensively in the chemical industry as a solvent for industrial extraction and rectification. Other uses for benzene include: degreasing and cleaning; as a solvent in the rubber industry; as an anti-knock fuel additive; and in the manufacture of styrene, cyclohexane, detergents, and pesticides.

Environmental Fate

Benzene (C_6H_6) is a volatile, colorless liquid with a molecular weight of 78.1. It is a highly flammable liquid with a characterisitc odor. It has a boiling point of 80.1°C and a flash point of -11°. Benzene is slightly soluble in water (0.178 gms/100 ml at 20°C) and has a density of 0.879. It also has vapor density of 2.77.

Benzene is photo-oxidized in the air and undergoes rapid bacterial degradation in the soil.

Health Significance

Benzene was selected as a critical contaminant since it is a human carcinogen and was observed in a variety of media at and near the site. No benzene was found in background or onsite surface soils.

Benzene was observed in only one surface water/sediment sample at the site. It was detected at 5J ug/l in standing water in the Central Tract (PW-2) and at 15J mg/kg in bottom sediments at the same location (PS-2). No criteria are available for surface water, although acute toxicity in freshwater aquatic life can occur as low as 5,300 ug/l and chronic effects can occur at even lower concentrations (EPA 1980). For humans, the ambient water concentration should be zero due to its carcinogenic potential. Since these levels may not be attainable, according to EPA (1980), the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-5} , 10^{-6}, 10^{-7}. The corresponding recommended criteria are 6.6 ug/l, 0.66 ug/l and 0.066 ug/l, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding water consumption, the levels are 400 ug/l, 40.0 ug/l, and 4.0 ug/l, respectively (EPA, 1980).

Benzene was observed only in two groundwater samples during the Remedial Investigation. A benzene concentration of 450 ug/l was observed in the shallow groundwater which discharges into the Ohio River (WP-3). A benzene concentration of 20 ug/l was also observed in the deep upgradient monitoring well

(MW-02). Using the one-hit linear model, the excess cancer risk for people exposed to 20 ug/l of benzene over a lifetime is 3.2×10^{-5}. This indicates a probability of 3 additional cases of cancer for every 100,000 people exposed. Although the benzene observations are a matter of concern, they occur sporadically and do not appear to be representative of general site conditions.

8.2.5.4 Chromium

Chromium is a metallic element which exists in several valance states. Chromium is used in the manufacturing of chrome-steel, chrome-nickel-steel alloys, cast iron, super alloys, and other alloys. Chromium salts are used extensively in the metal finishing industry and electroplating; they are also used as cleaning agents, and as mordants in the textile industry (Sittig, 1985).

Environmental Fate

The hexavalent and trivalent chromium compounds are the biologically and environmentally significant forms of the metal, but they have different chemical characterisitics. Hexavalent chromium is very soluble in natural waters. It is also a strong oxidizing agent in acidic solution, although it is relatively stable in most natural waters.

Trivalent chromium tends to form stable complexes with negatively charged organic or inorganic chemicals and thus its solubility and toxicity vary with water quality characteristics such as hardness and alkalinity.

Health Significance

Chromium was widespread and was found in elevated levels in the soil and water media at the Lees Lane Landfill Site. In a sample of waste material at the site (SS-22), the chromium concentration was 5,000J ug/l, while in background soils (SS-41) the concentration was 20J ug/l. Chromium concentrations ranged from 10J to 2,000J ug/l in "hot spot" soil samples at the site. The highest chromium concentrations were detected in the soils in the Central Tract. Station SS-23 contained a chromium level of 400J, while stations SS-24 and SS-26 contained 2,000J and 900J, respectively. The DHHS (1983) indicates the range of chromium normally found in surface soils is 5 to 3,000 mg/kg. The chromium levels detected at the Lees Lane Landfill are well within this range.

Chromium levels ranged from undetectable to 6.2 ug/l in surface waters at the site and no chromium was detected in the nearshore area in the Ohio River. Bottom sediment chromium levels ranged from 9.8 to 30J mg/kg. In order to protect freshwater aquatic life, a concentration of 21 ug/l hexavalent chromium should not be exceeded according to EPA (1980). The USGS alert level (1977) for chromium in river bottom material is 200 mg/kg. Neither of these criteria were exceeded.

Chromium was a common constituent in the groundwater at and near the site. The chromium level in the shallow upgradient well (MW-01) was 43 ug/l. The concentration ranged from 12 to 140 ug/l in the shallow groundwater at the site. The 140 ug/l level was observed in well LL-9, which also contained elevated levels of arsenic and lead. Additionally, 900 ug/l chromium was observed in LL-9 in April 1981. The deep upgradient monitoring well (MW-02) had a chromium concentration range of 120 to 57J ug/l between December 1984 and January 1985. In the deep monitoring wells, the chromium concentration ranged from 30J to 640 ug/l, with a mean concentration of 312 ug/l. Chromium was not observed in the Borden or L G & E industrial wells, however, a concentration of 12 ug/l was noted in an Indiana public water supply well (IN-1). Chromium was not detected in private wells sampled in the Riverside Gardens area. Although not directly applicable, the NIPDWR Maximum Contaminant Level for chromium is 50 ug/l. It is apparent that the deep upgradient well (MW-02) and many of the onsite wells had concentrations greatly in excess of this standard. It does not appear that the site is the only source of the chromium since it was found in elevated levels in the upgradient wells (MW-01 and MW-02). The site, however, does appear to be contributing substantially to the problem.

Since MW-03 contained the highest chromium concentration (640 ug/l), it will be used to evaluate potential adverse health effects. The acceptable daily intake (ADI) of chromium for man has been calculated to be 83 ug/l. It can be assumed that the majority of the chromium present in the monitor wells is in the hexavalent state; this compares to a daily intake of chromium through drinking water of 1,280 ug/day/person for MW-03. Although unlikely, it is possible that drinking water containing 640 ug/l over a period of several years may lead to an increase in the chromium concentrations of the liver and spleen. Chronic toxicological effects are possible at this level based on animal studies. No pathological changes have ever been associated with such low level exposures. The dermal effects from bathing in water containing 640 ug/l would likewise appear remote, although chromium is recognized as a potent sensitizer of skin.

8.2.6 Environmental Effects

As discussed in the Biota Investigation in Section 7.0, the diversity of habitats at the Lees Lane Landfill indicate the site could contain an abundant faunal population. Small mammals such as field mice and rabbits residing in the grass areas would be the most predominate species. Deer and other larger mammals may also frequent the riparian woods and woodland/brushland ecotone. Although large populations of waterfowl or wading birds are not known to inhabit the area, the marsh/open water areas could potentially attract them. The environmental receptors can be exposed to site contaminants by all exposure pathways. The most important pathway, however, is ingestion.

Table 8-9 provides the lethal concentrations or doses for various organisms ranging from sensitive aquatic invertebrates to small mammals. It is apparent from the table that environmental factors, such as water hardness, play an important role in determining the aquatic toxicity of the heavy metals. Heavy metals are much more toxic to aquatic life in soft water than in hard water. For example, in hard water the LC_{50} for lead in sunfish is 442,000 ug/l, while in soft water the LC_{50} is only 23,800 ug/l. This is also apparent with chromium.

TABLE 8-9
CRITICAL CONTAMINANTS
BIOTA ACUTE TOXICITY INFORMATION
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

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Critical Contaminant	Invertebrate	Coarse Fish	Game Fish	Small Mammals
Lead	612 ug/l = LC_{50} (soft water) 1,910 ug/l = LC_{50} (hard water) (*Daphnia magna*)	31,500 ug/l : LC_{50} (soft water) N/A (hard water) (Goldfish)	23,800 ug/l : LC_{50} (soft water) 442,000 ug/l - LC_{50} (hard water) (Bluegill)	520 mg/kg = oral TDLo (Rat)
Arsenic	5,278 ug/l : LC_{50} (*Daphnia magna*)	26,042 ug/l LC_{50} (Juvenile Goldfish)	41,760 ug/l LC_{50} (Bluegill)	
Benzene	380,000 ug/l : LC_{50} (*Daphnia magna*)	34,000 ug/l LC_{50} (Goldfish)	22,000 ug/l : LC_{50} (Bluegill)	5,600-5,700 mg/kg : LD_{50} (Rat)
Chromium (CR III)	2,000 ug/l : LC_{50} (soft water) 58,700 ug/l : LC_{50} (hard water) (*Daphnia magna*)	4,100 ug/l : LC_{50} (soft water) N/A (hard water) (Goldfish)	7,460 ug/l : LC_{50} (soft water) 71,900 ug/l : LC_{50} (hard water) (Bluegill)	1,870 mg/kg = oral LD_{50} (Rat)
(CR VI)	17,300 ug/l : LC_{50} (soft water) 40,600 ug/l : LC_{50} (hard water) (Snail)	37,500 ug/l : LC_{50} (soft water) 124,000 ug/l : LC_{50} (hard water) (Goldfish)	118,000 ug/l : LC_{50} (soft water) 133,000 ug/l : LC_{50} (hard water) (Bluegill)	110 ug/m^3 = Inhalation TCLo (Hamster)

TCLo - Toxic Concentration Low - the lowest concentration of a substance that has produced any toxic effect.
LC_{50} - Lethal Concentration Fifty - concentration of a substance, exposure to which is expected to cause the death of 50% of test animals.
LD_{50} - Lethal Dose Fifty - concentration of a substance, exposure via any route but inhalation is expected to cause the death of 50% of test animals.
LDLo - Lethal Dose Low - the lowest dose of a substance, introduced via any route but inhalation, that has been reported to cause death in humans or animals.
N/A - Not Available

Sources: Verschueren, K. 1983.
Sax, N.I. 1984.

None of the critical contaminants are readily bioaccumulated in the food chain, although chromium, lead, and arsenic can accumulate in the tissues of exposed organisms. Many studies suggest that metals biomagnify similar to DDT. Connell and Miller (1985) report that food chain enrichment of metals does not occur, except for mercury. Rather, organisms exposed to the highest metal concentrations generally contain the greatest amounts. For example, detritus-feeders exposed to contaminated bottom sediments can contain higher metal amounts than upper trophic level feeders. Other factors determining metal concentrations in biota include age and preferential uptake and elimination of different metals by the body.

Levels of the critical contaminants in surface waters and groundwater were well below the lethal concentrations shown in Table 8-9, and do not represent a significant threat to environmental receptors at these concentrations.

All reported soil concentrations of arsenic were below the USGS alert level of 200 mg/kg, while a few "hot spot" soil samples contained concentrations of chromium and lead in excess of the USGS alert levels, 200 mg/kg and 500 mg/kg respectively.

In summary, the concentrations of the critical contaminants observed during the remedial investigation do not represent a significant threat to the environmental receptors at the Lees Lane Landfill Site. Biota in continued direct contact with elevated contaminant levels in selected "hot spot" soil areas may experience symptoms of chronic toxicity, however, no acute toxicological effects would be expected at the current contaminant levels.

8.3 Objectives of Remedial Action

The only potential public health problem at the Lees Lane Landfill Site is related to the elevated chromium levels detected in the groundwater. Although the site is contributing to the elevated levels, it is not the only source since upgradient wells also contained elevated levels. Chromium was not detected in residential wells east of the site. Since groundwater flow is predominantly toward the Ohio River it is unlikely the residential wells will be affected in the future. Chromium was also not detected in the industrial process wells north and south of the site, however it was found at low levels in the Indiana public water supply wells across the Ohio River. It is not known if this chromium is related to elevated levels at the landfill.

Table 8-10 provides a summary of the potential public health concerns resulting from the public health and environmental assessment for the Lees Lane Landfill Site. As shown in the table, there is no current evidence of an offsite problem related to the landfill site.

Future potential public health concerns are related to the elevated chromium levels in the groundwater at and upgradient of the site and to the potential release of methane and hazardous gases to the air and subsurface.

Since elevated chromium levels were detected in upgradient wells and no downgradient offsite impacts are evident, no remediation for the groundwater is recommended at this time. It is recommended that a monitoring program be implemented to establish baseline conditions at the site and to serve as an early warning system should site conditions change.

The existing gas collection system installed between the landfill and the Riverside Gardens residential area, although working inefficiently, appears to have alleviated problems related to the migration of landfill-generated gases in the subsurface. It is recommended that the gas collection system be repaired or a new system constructed and that a routine monitoring program be implemented for gas migration outside the collection system and in the Riverside Gardens area. If the existing gas collection system is repaired or a new system constructed, proper maintenance will be required to prevent operational problems. Additionally, the ambient air should be monitored on the site to provide information on air quality and its potential effects.

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TABLE 8-10
PUBLIC HEALTH CONCERNS AND RECOMMENDATIONS
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Affected Area	Release Mechanism	Affected Media	Evidence of Current Public Health Concern	Potential Future Public Health Concern	Recommendations
Offsite	Leachate	Groundwater	No	Yes	Monitoring
	Runoff	Surface Water	No	No	None
		Sediments	No	No	None
		Surface Soil	No	No	None
	Gas Production	Gas Migration	No	Yes	Gas Collection System
		Air	No	Unknown	Monitoring
Onsite	Unrestricted Access	Surface Water	No	No	None
		Sediments	No	No	None
		Surface Soils	No	No	Cover "hot spots"
		Air	No	Unknown	Monitoring